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Protecting Rights and Promoting Freedom on the Electronic Frontier

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UNEARTH THE FULL STORY BEHIND THE LEGEND OF ZELDA

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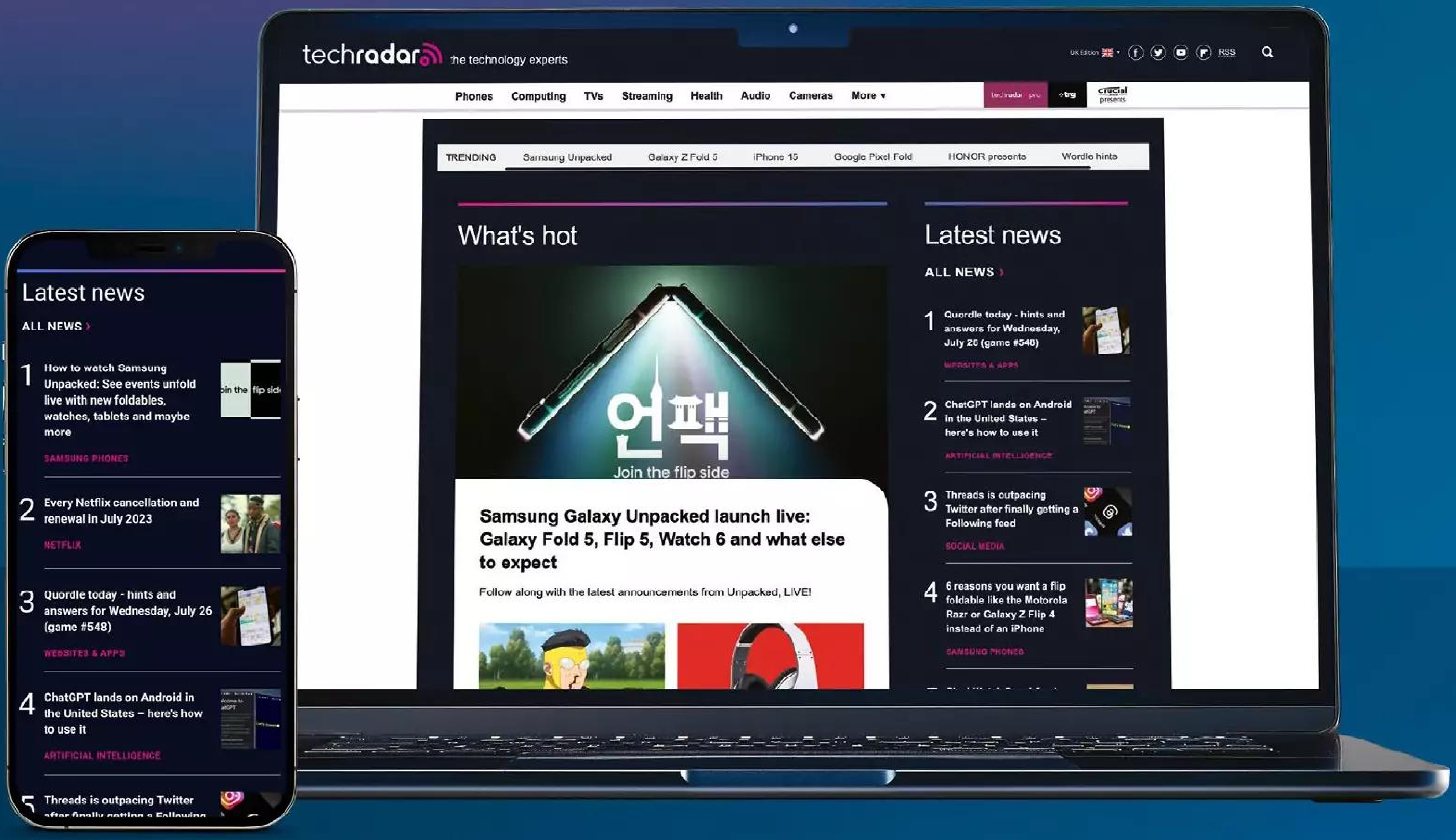

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Next Issue On Sale February 25, 2025

EXTRA DIGITAL FEATURES

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Guy
Cocker

THE STATE OF THE ARC

WELCOME to the February edition of *Maximum PC*, coming to you from the Las Vegas Strip, where I've just witnessed the next year of computing unfold before my eyes at the Consumer Electronics Show. We've had Nvidia show off its next generation graphics cards, which will be with us just after this issue goes on sale. AMD has confirmed its next-generation handheld processor, the Ryzen Z2 Series, as well as its next-generation GPUs, the Radeon RX 9000 series. And Intel has showed off its Core Ultra 200S line, which aims to bring AI smarts and lower power consumption to the desktop. I'm busy planning future cover builds starring these new components with our master builder, Zak, and you can get the full lowdown on all the CES news in our Quickstart section, beginning on page 8.

In this month's cover build, we look at a high-value 1440p gaming system based excusively on Intel components. The company's second-generation graphics card line is here (reviewed on page 74), and we couldn't be happier to welcome a new high-value champion in the form of the Arc B580. This card well and truly brings the fight to the more expensive RTX 4060 and RX 6600, meaning that if you have $250 to spend on a GPU, there's no doubt this is the one you should buy. Our builder, Zak, has paired it with an Intel Core Ultra 5 245K to create this year's best-value gaming PC—a system more than capable of delivering 1440p (and even 4K) graphics at well under $1,500. You can read all about it, including our video discussing it, on page 16 onward.

We also have some brilliant features to kick off the new year. I'm sure it's not just us who look at some of the generation-on-generation improvements in CPUs and GPUs, and are disappointed in the single-digit percentage gains that have become the norm. It sometimes feels like it's been a while since we've had any genuine leaps forward, which is why Ian Evenden looks at whether we've hit 'Maximum PC'. Thankfully, he finds plenty to get excited about, so head to page 32 to find out where computing is going next.

Elsewhere, Nate Drake goes back to the original use of AI in computing—that of programming enemies in gaming, and looks at how these bots have progressed over the years, and where they may be going next. Zak also finishes his comprehensive guide on how to install Windows 11—I'm not up to his gold standard of reinstalling every 3-6 months, but when I do next flatten my system, I'll have the most thorough guide ever to help me!

We also have some brilliant tutorials, including our lead item on how to use Windows Recall. This feature has been controversial ever since Microsoft unveiled it, as it requires your system to take regular snapshots of what you're doing in order to recall them later. However, as the sort of person whose brain works in the slightly scattergun approach that would benefit from being able to use search terms such as 'show me the email I sent to my friend last month about holiday ideas', I'm ready to sign up. We also have guides on how to improve your Wi-Fi performance, set up your own data vault, and use PowerToys to do things in Windows you never knew were possible.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Nvidia announces RTX 50 graphics

The new Blackwell promises big performance gains

NVIDIA CEO Jensen Huang used the Consumer Electronics Show to announce the first batch of RTX 50 GPUs. Four models will deploy the company's latest Blackwell graphics architecture. The flagship RTX 5090 Founders Edition is a two-slot GPU with 32GB of GDDR7 RAM, memory bandwidth of 1,792GB/sec, and 21,760 CUDA cores. It's currently priced at $1,999.

Nvidia began its Blackwell demo by showcasing gameplay of a next-gen *Assassin's Creed* game to demonstrate the architecture's ray tracing features. It has also shared a benchmarking video of *Cyberpunk 2077*. Using the RTX 5090, it ran at 242fps, compared to 109fps on the RTX 4090, at least with DLSS used.

The RTX 5080 has a more modest price, the same $999 as the RTX 4080 Super. It comes with 16GB of GDDR7 memory with a bandwidth of 960GB/sec, and 10,752 CUDA cores, the latter representing an uptick over the 10,240 cores of the 4080 Super.

As for the new GeForce RTX 5070 Ti and GeForce RTX 5070, they're priced at $749 and $549. However, both mid-range graphics cards bring modest at best spec bumps. The RTX 5070 has the same 12GB of VRAM as a 4070, albeit upgraded to GDDR7, plus 6,144 CUDA cores—a small bump over the 4070's 5,888 cores. The RTX 5070 Ti is a considerable improvement over the 4070 Ti, with 16GB of GDDR7 RAM, 8,960 CUDA cores, and 896.3GB/s of memory bandwidth, though the gap over the 4070 Ti Super is smaller.

All the latest GPUs use PCIe Gen5, as well as DisplayPort 2.1b UHBR20. This means the Blackwell architecture can support 8K displays with a refresh rate of up to 165Hz. A more detailed examination of Nvidia's in-house benchmarks reveals that the performance gains of the RTX 50 series GPUs are largely down to the DLSS (Deep Learning Super Sampling) 4 software suite, including a new transformer model for Super Resolution upscaling, and most importantly, 'Multi-Frame Generation'. The latter can generate up to three additional frames for every frame the GPU renders.

The RTX 50 series offers huge performance gains, but only when using DLSS 4.

© NVIDIA

The upcoming RTX 50 series GPUs were benchmarked in this way with DLSS 4 against the equivalent RTX 40-series, which used DLSS 3. This is understandable up to a point, given that DLSS 4 is not fully supported on older GPUs. However, a chunk of the claimed performance uplift is a direct consequence of those extra generated frames.

Nvidia has released other software updates for the RTX 50 series. These include upgrades to RTX Video and Remix. The RTX 50 series also supports FP4. This is designed to address the issue that AI models are growing larger and more complex. FP4 is a lower quantization method designed to reduce model sizes.

Nvidia claims that compared to the previous FP16, its latest GPUs use less than half of the memory and offer twice the performance. A GeForce RTX 4090 using FP16 with the FLUX.1 [dev] image generator can generate images in 15 seconds with 30 steps. With a GeForce RTX 5090 using FP4, images can generate in about five seconds.

The RTX 50 series encoders also support the 4:2:2 pro-grade color format, doubling usable color information. Compared to previous GPUs, the chips can decode up to eight times the 4K 60fps video sources per decoder. This provides better color depth, though gains will depend on Nvidia's graphics card.

All four models of the RTX 50 series feature Nvidia's ninth-generation video encoder NVENC, offering a five percent improvement in video quality for HEVC and AV1 encoding (BD-BR). There's also an 'AV1 Ultra Quality' mode that achieves five percent more compression at the same quality. The chips include the sixth-generation Nvidia decoder, doubling the decode speed for H.264 video. Look out for our reviews when we get our hands on them. **–ND**

> “Nvidia claims its latest GPUs use under half the memory and twice the performance

US TREASURY HACKED

STATE-BACKED HACKERS ESCALATE ATTACKS ON WESTERN TARGETS

IN A LETTER TO LAWMAKERS, the US Treasury department has claimed that a "major incident" occurred late last year, whereby its systems were accessed by a "threat actor".

The breach was discovered on December 8 when hackers compromised third-party cyber security provider BeyondTrust. They then stole a key that enabled them to remotely access US Treasury workstations and access unclassified documents.

If true, this would be just one part of a recent cyber espionage campaign against US and other western governments. The Treasury attack certainly fits the pattern of known Chinese APTs in that it involved compromising a third-party security service. The hackers also used 'living off the land' techniques by exploiting tools to compromise systems, which matches the techniques of certain APT groups like Volt Typhoon.

The Treasury is working with the FBI and CISA to assess the full impact of this breach. However, officials say there is no evidence of continued unauthorized access. **–ND**

OPENAI BEGINS 2025 PROFIT PUSH

Major overhaul planned

OPENAI HAS REVEALED details about how it plans to adopt a new corporate governance model. This is to be achieved through restructuring the company as a PBC (Public Benefit Corporation). In theory, OpenAI exists to make profit, and for the public good. Rivals like Elon Musk's xAI use a similar structure.

The non-profit arm will live on. Owners will be given shares in the PBC to compensate them for no longer effectively being in control of the company. This addresses concerns raised when the non-profit's board tried to remove chief executive Sam Altman in 2023.

OpenAI founding member Musk has sued Altman and the company for supposedly putting profits and commercial interests ahead of the public good. The case is ongoing, despite OpenAI's move to a PBC structure.

The restructuring also comes as the AI firm faces mounting losses. Despite the backing of tech giant Microsoft, in 2024 OpenAI faced around $5 billion in losses on $3.7 billion in revenue. **–ND**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **MICROSOFT ASKS TO BE HACKED**
'Zero Day Quest' will invite hackers to report bugs. Bounties range from $4,000 to $30,000.

✓ **SONY KEEPS LIVE SERVICES**
CEO Hermen Hulst promises the company will continue releasing live service games.

✓ **DOOM CAPTCHA BUILT**
Guillermo Rauch has recreated a secret level of the original *Doom.* Users must kill at least three monsters to prove they're human.

TRAGEDIES

✗ **ASSASSIN'S CREED ORIGINS REVIEW BOMBED**
A Windows 11 update (24H2) made the game unstable and likely to crash.

✗ **TESLA SALES DROP**
Overall annual sales for 2024 are reported to be one percent down from 2023.

✗ **CHINA'S ROCKET FAILS**
The Kinetica-1 rocket lost altitude three seconds after third-stage ignition, leading to self-destruction.

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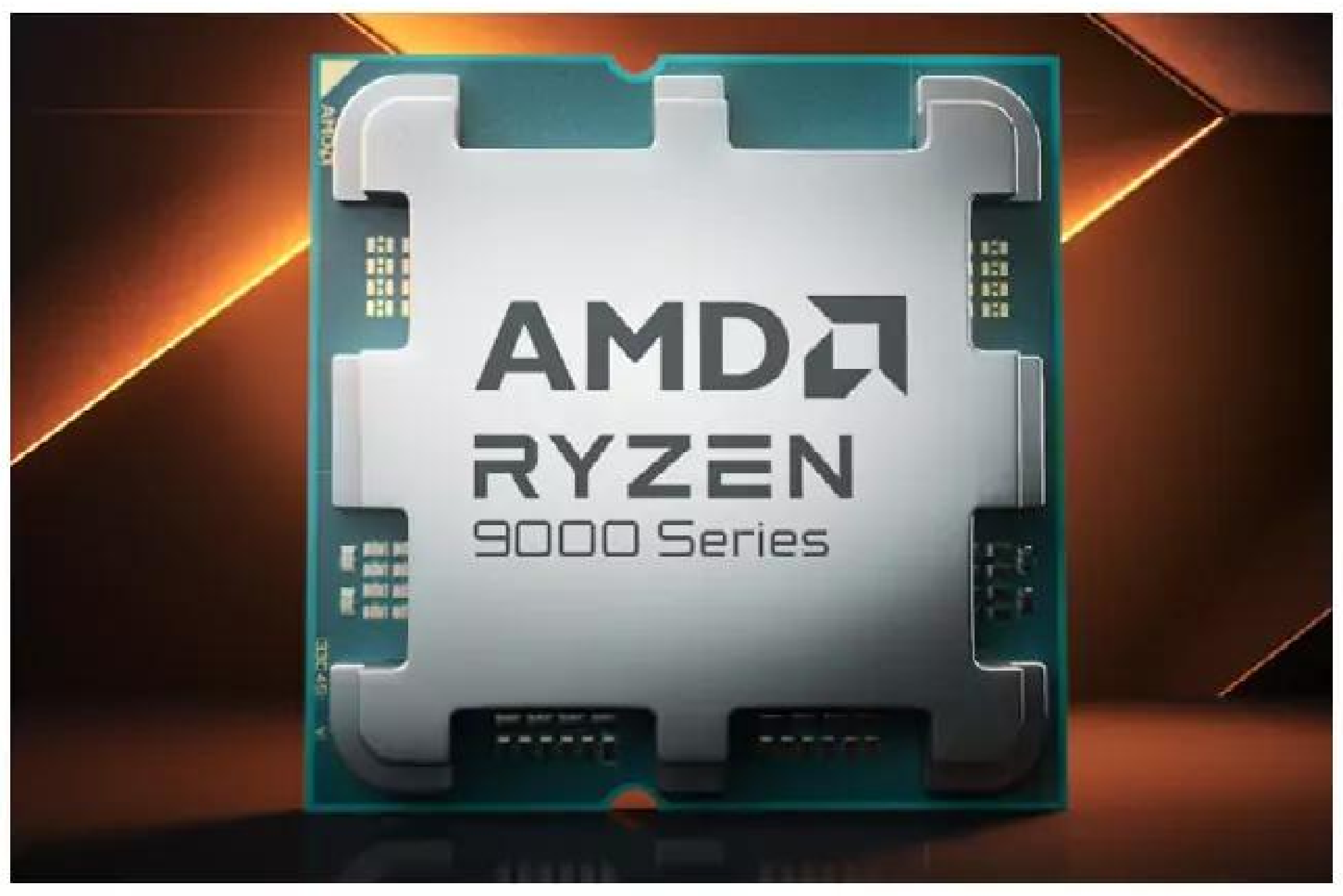

AMD UNVEILS NEW GAMING AND AI CHIPS

AMD Ryzen AI Max series announced at CES 2025

AMD KICKED OFF CES with announcements for its Ryzen 9950X3D and 9900X3D processors. The Ryzen 9950X3D is a 16-core chip for gamers, using 16 of AMD's Zen 5 CPU cores, plus 32 threads. It also has a 144MB cache, including 128MB of AMD's 2nd Gen 3D V-cache.

The maximum boost clock is 5.7GHz and the TDP is 170W, an increase of 50W over the AMD Ryzen 9 7950X3D. AMD compared gaming performance of the 9950X3D and 7950X3D across 40 titles and claims an eight percent average improvement.

AMD has also introduced the Ryzen 9000HX Series for laptops. This includes the flagship Fire Range Ryzen 9 9955HX3D with 16 cores, 32 threads, a 144MB cache, and a maximum boost of 5.4GHz. incorporating AMD's Zen 5 architecture.

AMD is also releasing two non-X3D chips: the 16-core Ryzen 9 9955HX and 12-core 9850HX. The TDP of all three CPUs is 54W. Unlike the desktop series of processors, the company hasn't provided any benchmarks, nor a specific release date beyond the first half of 2025.

CES also hosted AMD's reveal of the Ryzen Z2 processor, designed for gaming handhelds. The Z2 Extreme features four Zen 5 cores and Zen 5c cores, plus 12 RDNA 3.5 graphics cores, and a max boost of 5.0GHz. The two other chips, the Z2 and Z2 Go, will have eight and four cores respectively, both offering 12 graphics CUs, but the Z2 Go is based on older Zen 3 hardware and RDNA 2 graphics.

An AMD spokesperson claimed that the Z2 series would be "coming to market from a number of partners", including the ROG Ally and Steam Deck. A Valve representative has since clarified that there will be no new Steam Deck based on the Z2. **–ND**

GOOGLE MAKES QUANTUM BREAKTHROUGH

Is Willow a gamechanger for supercomputers?

IN 2019, Google researchers claimed to have built a machine capable of performing tasks that were not possible with traditional supercomputers. The designation of this machine as a 'quantum computer' was controversial, particularly as supercomputers became more powerful than Google's creation.

Now, the ball is back in Google's court. The company claims its 'Willow' computer chip took less than five minutes to perform a mathematical calculation that one of the world's most powerful supercomputers couldn't complete in 10 septillion years. To put this into perspective, the universe is 0.013 septillion years old.

In essence, Willow is a memory chip. Like its predecessor, Sycamore, it uses a superconducting super-cooled capacitor called a 'Transmon'. This can combine multiple qubits into a single logical qubit.

The challenge that has eluded quantum computer engineers for almost 30 years is to suppress errors as multiple qubits succumb to environmental noise. However, Google's breakthrough centers on reducing errors in qubits. Willow can do this so it can reach the 'threshold level' for a workable logical qubit.

This has been achieved by making changes to how the Willow chip is made, boosting its physical qubits to 105. Google's discovery is promising, and suggests that a predictably logical qubit can be built by adding more physical qubits while keeping noise below the threshold level.

While this represents a step in the right direction, experts like Professor Winfried Hensinger have pointed out that the processing power of the chip is too small for real-world applications, which would take millions of qubits. Willow also can't perform logical operations, which requires numerous logical qubits being linked. However, Google has revealed a roadmap with further quantum computing milestones it hopes to achieve. **–ND**

US Supreme Court kills Net Neutrality

A FEDERAL APPEALS COURT has dealt a blow to net neutrality regulation by ruling that the Federal Communications Commission lacks the authority to regulate ISPs as utilities. The US Court of Appeals for the Sixth Circuit declared that "broadband internet service providers offer only an 'information service'".

This is significant, as classifying ISPs in this way gives the FCC much less authority to regulate their activities. As such, it effectively ends the Biden administration's efforts to restore Obama-era internet regulations.

This may be good news for big business, but not necessarily for US consumers. For instance, a provider like Comcast could prioritize its own 'Peacock' video streaming service, while reducing the quality of Netflix content.

This precedent established that courts should defer to federal agencies when it came to interpreting their own rules. In this case, the FCC's decision to classify ISPs as utility providers meant that it had greater oversight. Thus, any corporation with special interests can now sue federal agencies in the hope that a judge may interpret regulations more liberally. The FCC's Jessica Rosenworcel has called on Congress to enshrine net neutrality principles into federal law, though this seems unlikely, given the current US political climate. **–ND**

The principle of net neutrality is that all traffic should be treated equally.

LG Reveals bendable 5K OLED monitor

LG has cemented its reputation for cutting-edge monitors with the new addition to its UltraGear GX9 series. The 45GX990A is a 45-inch OLED that curves to a 900R radius.

While this isn't the first bendable OLED monitor, it's the first with 5K2K (5,120 by 2,160 pixels) resolution. It also includes an upgraded version of LG's dual mode, with customizable aspect ratios (21:9 or 16:9) and picture sizes (39, 34 or 27 inches).

LG will also offer a non-bendable version of the monitor (45GX950A). The pricing and release dates of both models have yet to be confirmed. Although LG has promised to offer a variable refresh rate, it has yet to reveal what the refresh rate will be with the monitor's native resolution. **–ND**

MediaTek unveils Dimensity 8400

MediaTek has announced its latest Dimensity 8400 chip, with the promise to bring the first all-big-core chip design to the premium smartphone segment. The chipset has eight Arm Cortex-A725 cores with speeds of up to 3.25GHz. It also has a 44 percent peak power usage reduction compared to its predecessor.

This is coupled with MediaTek's NPU 880 for AI tasks. The chipset also includes the Arm Mali G720 GPU, which is 24 percent more efficient than the 8300 series. Other features include a 5G-A modem and NOS (Network Observation System) technology for switching between 5G and Wi-Fi networks. Xiaomi's Redmi Turbo 4 is already using a customized version of the chipset, which it calls Dimensity 8400-Ultra. **–ND**

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Jarred Walton

TECH TALK

Nvidia RTX 50-series pushes AI to the forefront

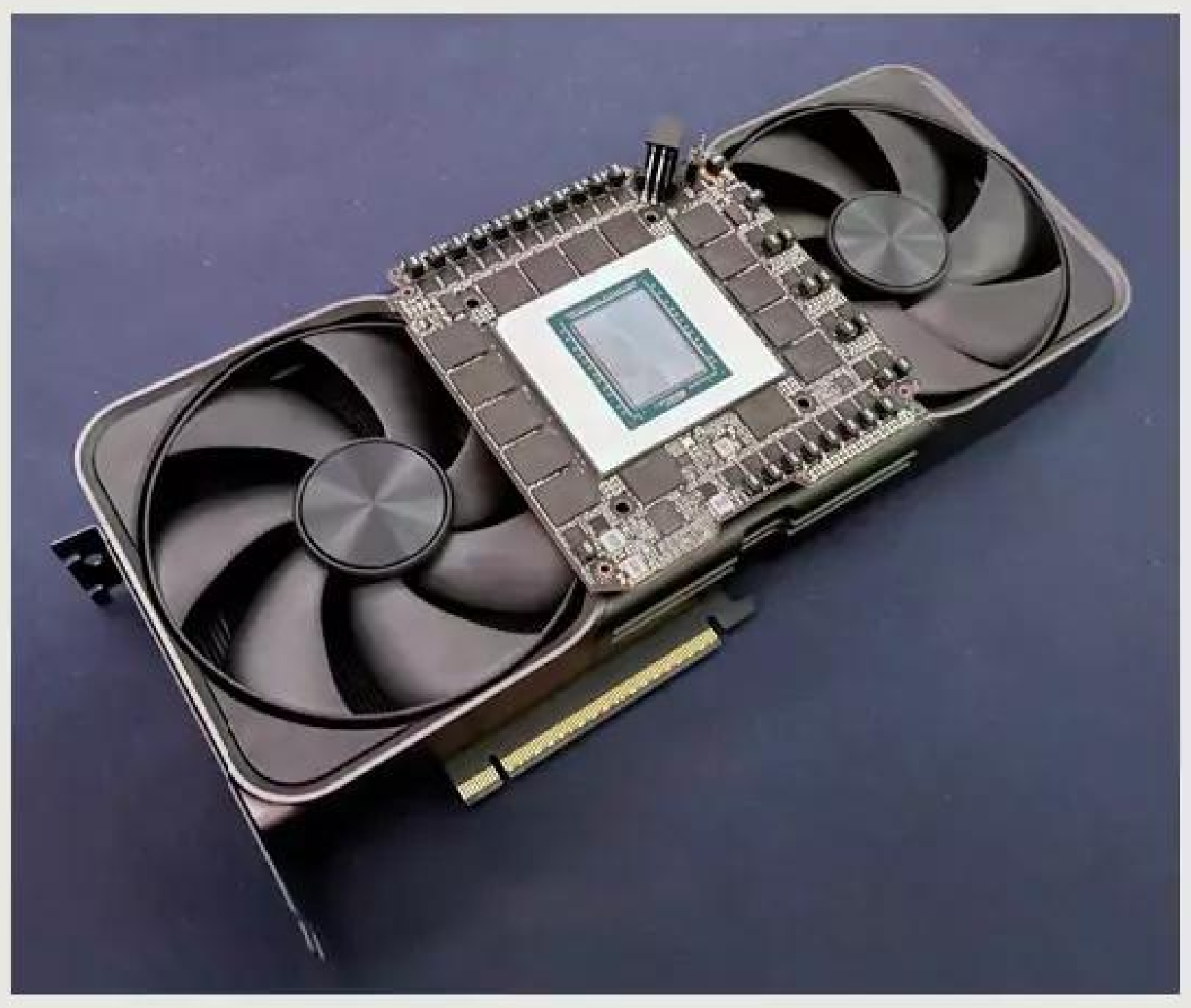
TWO YEARS ON from the launch of the RTX 4090, Nvidia officially announced its Blackwell RTX 50-series GPUs, with availability starting January 30. Several of the models offer relatively incremental upgrades over the existing 40-series cards, but the top-end RTX 5090 will provide a big boost to gaming performance, and perhaps a bigger boost to AI workloads.

The GB202 chip at the heart of the 5090 comes with 170 streaming multiprocessors, 21,720 CUDA cores, and 32GB of GDDR7 on a 512-bit memory interface—clocked at 28 Gbps. That's 1.8TB/s of memory bandwidth, about 80 percent more than the prior generation RTX 4090, 27 percent more raw compute, and 33 percent more VRAM capacity. But while the improvement in like-for-like compute may not be that significant, Blackwell also adds native support for FP4 to the tensor cores, running twice as fast as Ada's FP8 code. That gives the 5090 up to 3.4 PetaFLOPS of FP4 throughput, which Nvidia classifies as 'TOPS' (teraOPS).

Similar to the 40-series, the 50-series will depend on new features to distance itself from the previous-generation GPUs. Nvidia showed performance where the 5090 was over twice as fast as the 4090. However, the 5090 was using Multi Frame Generation (MFG), a new technology that leverages Blackwell's FP4 compute.

MFG uses Nvidia's tensor cores and runs faster than the Optical Flow Accelerator used for framegen in the 40-series. Because it's software-based, that makes it easier for Nvidia to enhance and improve the functionality. Instead of generating a single frame with AI, it can generate up to three in between previously rendered frames. That's potentially a 4X improvement in 'frame rate'—it's in quotes because these generated frames don't use new user input.

> Nvidia CEO Jensen Huang said DLS 'predicts the future rather than interpolating the past'



The RTX 5090 will likely be king until Nvidia's next architecture.

I asked Nvidia CEO Jensen Huang about DLSS 4 MFG, and he made a rather bold claim, saying DLSS 4 "predicts the future rather than interpolating the past." That turned out to be incorrect, as it's still using interpolation. But it got me thinking: was Jensen incorrect, or already talking about the future?

DLSS 4 uses interpolation for MFG, but will we get DLSS 5 with frame projection? That seems to be where Nvidia is heading, given what we heard about Reflex 2.

Reflex 2 predicts where the camera will be before rendering, and then, just before sending the rendered image to the monitor, it samples user input and warps the camera position. Certain parts of the screen that were previously occluded could become visible. In a demo, Nvidia showed these as white pixels. A trained AI in-painting algorithm runs to fix the missing pixels. If Nvidia can already do this with Reflex 2, how close is it to projecting one or even multiple frames ahead?

There will, of course, be rendering errors with projection. But when the frame rate is high enough, the occasional artifact doesn't stay on screen long enough to detract from the gaming experience. With MFG, Nvidia seems to be aiming for generated frame rates of at least 120fps, so each frame would only be visible for less than 8.3 milliseconds.

How does MFG running on the RTX 50-series feel? With a 240Hz 4K display using upscaling and MFG running on an RTX 5090, it was smooth. But I wonder how that will translate down to the eventual RTX 5060 level of hardware. I suspect you'll want the base to be 40fps or higher to get a good experience, which means generated fps of 160 or more—which will still feel like 40fps, even if it looks like 160.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE BEST LAPTOP GRAPHICS CARDS

EASILY THE MOST IMPORTANT part of a gaming notebook is its GPU, but choosing based purely on the model of GPU is sadly no longer enough. You now need to know how much power the laptop manufacturer is letting that GPU chow down on, commonly referred to as the TGP. That's why our very favorite current mobile GPU isn't necessarily the most powerful; it's a bit more complicated than that.

5 AMD RADEON 890M

'Integrated' used to be a dirty word when it comes to gaming graphics, but AMD has recalibrated expectations in recent years, and its new Strix Point APUs with their RDNA 3.5 Radeon 890MiGPU is pretty damned impressive. We were already into the 780M and its 1080p gaming chops, but the new 890M of the Ryzen AI 9 HX APUs is another level beyond that. Okay, it's still behind the likes of an Nvidia RTX 4060 discrete GPU for frame rates, but for 1080p mobile gaming on a tight budget, the 890M makes a lot of sense. Laptops from **$1,000, www.amd.com**

4 NVIDIA RTX 4090

Put the RTX 4090 in too slim a laptop chassis, and it can even end up slower than a 4080. That's why the 4090 isn't our automatic pick for the top slot. However, give it a proper desktop replacement rig, and there's no doubting that it's the fastest mobile GPU, and by some distance. The problem, then, is pricing. Portables with the 4090 fitted are terrfyingly expensive. In the end, it's hard to justify that premium. But if you're not price sensitive, and want the best possible performance, it has to be a 4090 in a big laptop. Laptops from **$2,500, www.nvidia.com**

3 NVIDIA RTX 4070

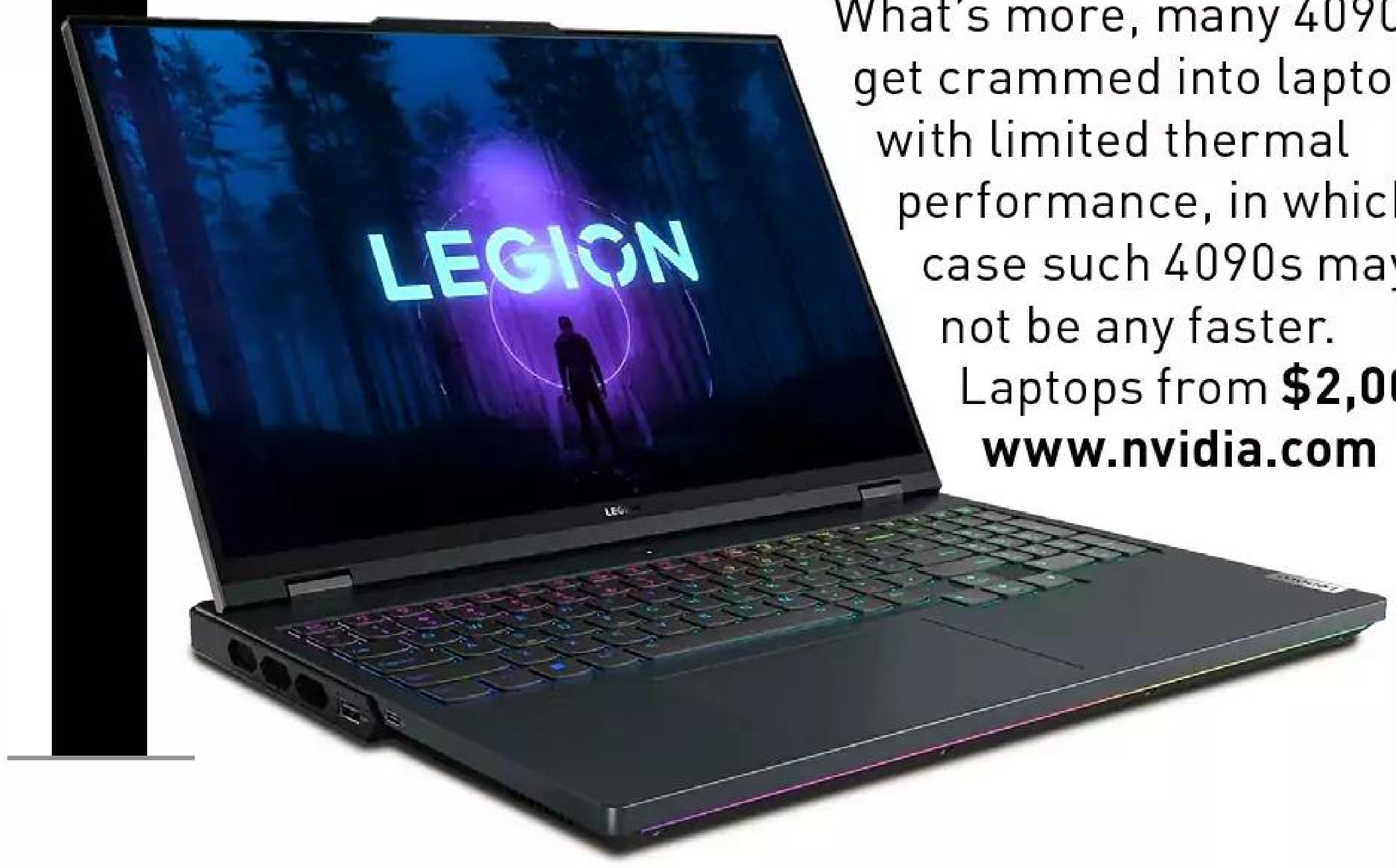
The fact that this mobile 4070 is really a slightly tweaked RTX 4060 Ti desktop GPU, and thus only offers 8GB of VRAM and a 128-bit memory bus, is slightly annoying. However, with the same level of gaming performance as the mobile RTX 3080 of the previous generation, the RTX 4070 delivers a frame rate experience that belies its pricing in the gaming laptop world. These PCs are seriously affordable, something that wouldn't be possible with the bigger, more expensive GPU from the desktop 4070. Laptops from **$900, www.nvidia.com**

2 NVIDIA RTX 4060

The RTX 4060 delivers genuinely impressive 1080p gaming performance to the sub-$1,000 entry-level gaming laptop market and frame rates that would have been thoroughly mid-range one generation ago. You're also getting DLSS 3 and Frame Gen in the bargain. Obviously, there are much faster mobile chips available, but the price-to-performance compromise is very strong here. When you add in that unbeatable Nvidia feature set, this has to be the best real-world gaming GPU right now. Laptops from **$800, www.nvidia.com**

1 NVIDIA RTX 4080

The RTX 4080 isn't the most powerful laptop graphics chip, but it offers a great balance between power efficiency and outright gaming performance. You'll be amazed what this GPU is capable of, especially with a little help from DLSS upscaling and frame generation. It's also more affordable than the RTX 4090, even if it's not cheap. What's more, many 4090s get crammed into laptops with limited thermal performance, in which case such 4090s may not be any faster. Laptops from **$2,000, www.nvidia.com**



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Jeremy Laird

TRADE CHAT

Fun and graphics card games at CES 2025

WE ALL KNEW what was coming at CES: a bunch of graphics cards from AMD and Nvidia. They were pretty much exactly as predicted, albeit with some surprises. AMD managed to botch the launch of its RDNA 4 cards, while Nvidia played 3D chess with the pricing of its new RTX 50 cards.

As the old saying goes, AMD never misses an opportunity to miss an opportunity. So it was at CES 2025 in Las Vegas. We were all expecting AMD to go big with the new RDNA 4 GPUs during its CES keynote. In the end, RDNA 4 was barely mentioned.

There were more details on RDNA 4 in the pre-release materials handed to journalists prior to the keynote than in the actual keynote. AMD reps claimed the sparsity of info was due to time constraints. The organizers of CES, we were told, only allow for 45 minutes for such talks. AMD had a lot to announce, and RDNA 4 needed more than five minutes shoehorned into a broader presentation.

Personally, I don't buy that. In the pre-release slides given to journalists, AMD named the first two RDNA 4 cards as the Radeon RX 9070 and 9070 XT—again, just as expected, slating them for a launch in the first quarter of 2025. That means they'll be out by the end of March at the latest, which in turn means they're imminent. So imminent, I can't believe AMD didn't plan to go into more detail with RDNA 4 at CES.

So, what happened? In a word, Nvidia. Okay, AMD's keynote came before Nvidia's, but it's a small world, and I suspect AMD got wind of some of the details of Jensen Huang's upcoming keynote. I think AMD found out about the pricing of Nvidia's new GPUs, and it wasn't what they were expecting.

Leading up to CES, all the noise involved very big-dollar figures attached to Nvidia's new RTX 50 graphics cards. As it turned out, the new RTX 5090 is pretty expensive at $1,999. The rest? Not so much. The RTX 5080 isn't exactly cheap at $999, but it's priced lower than the $1,199 RTX 4080 was at launch two years ago.

> As it turned out, the new RTX 5090 is pretty expensive at $1,999. The rest? Not so much

RADEON
TUF GAMING

AMD needs to get the pricing of its new RDNA 4 GPUs just right.

The $749 RTX 4070 Ti and $549 RTX 5070 likewise came in lower than expected, too, so I suspect that AMD decided to take a little time to decide how to react. After all, AMD is already on record as characterizing RDNA 4 as being about value for money. With RDNA 4, AMD is not going after the very high end; it's aiming for maximum bang for your buck in the mid range and below.

Another of those pre-keynote slides from AMD showed that the new 9070 XT is aimed at existing Nvidia GPUs up to and including the RTX 4070 Ti. The slide didn't clarify if that positioning was predominantly price or performance related, but taking everything we know into account, the pricing of the new RTX 5070, and perhaps to some extent the 5070 Ti, are critical to the value proposition of AMD's new GPUs.

My hunch is that AMD had planned to announce the new RDNA 4 cards in more detail, including pricing. But then, the $549 RTX 5070 suddenly made their planned price points for the new RX 9070 and 9070 XT look less appealing than intended.

AMD could, of course, have made an adjustment, but perhaps it preferred to take a little time to be sure about Nvidia's pricing, and also to get a better feel for exactly how their new cards compared in terms of performance.

In that sense, my 'missed opportunity' quip was unfair. I think AMD probably made the right call this time. RDNA 4 is absolutely going to trade on value, so pricing is critical. It made the mistake of positioning cards like the RX 7800 XT too high at launch, only to see real-world prices tumble. Avoiding a repeat of that mess with RDNA 4 is surely critical.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

© ASUS

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Save CCTV system
> Multiple audio devices
> Encrypted download

qsee
4K Ultra HD

Old cameras can be reused if they're ONVIF-compatible.

© Q-SEE

Q-See CCTV replacement

I have a self-installed security system by Q-See from 2012—eight QCN8093B cameras with motion detection, night vision, playback, and so on. Q-See went under during Covid, and although my system works, I would like to plan for when the computer system that came with it dies. The cameras are POE, and the computer is a proprietary system with 8TB of Western Digital HD storage.

I could build a new system, but I don't know where to start. I haven't found software that seems to be able to collect data from multiple security cameras to do what this system does. Any ideas? I am not afraid to build a new computer if that's what it takes, I just don't know where to go for software. — **Dorothy Meister**

THE DOCTOR RESPONDS: The Q-See brand was resurrected in 2022 as Qsee, but the new company has made it clear that it won't support legacy products, which is why Dorothy has this issue. Her decision to act must have been caused by a premonition, because between contacting the Doc and responding to his queries, one of the drives had died.

The system runs two hard drives, so while she waits for a replacement, she is at least able to continue using it. The Doc's hunch is that the system will work for many years yet—way beyond the life of the drives—but it's still an idea to plan ahead.

Many Q-See models were based on OEM Dahua kit, which bodes well for cannibalizing them in a different system as they're likely to support the ONVIF protocol; however, they're likely to need a fair bit of setting up—including a full hardware reset. One excellent online resource is IPcamtalk. In particular, follow the thread at https://ipcamtalk.com/threads/q-see-cam-issue.62551, which covers the specifics of Dorothy's exact model.

IPcamtalk is home to Blue Iris, which gives you NVR functionality from your main PC. This would require Dorothy to connect the cameras directly to her network via intermediary hardware, such as a PoE switch, and would mean leaving her PC switched on 24-7. Another option is to explore NAS-based systems, but as both Synology and QNAS charge for their surveillance packages, you might want to investigate our tutorial on motionEye from the July 2023 issue (see https://github.com/motioneye-project/motioneye), which pairs with our self-built NAS server build from the April 2024 issue. It's not that polished, but does offer core features like motion detection triggers and setting zones for each camera.

Alternatively, Dorothy could source a replacement NVR device—the forum recommends EmpireTech (https://empiretech01.com/) as a potential alternative that could work with legacy Q-See cameras, but we'd recommend getting in touch directly to enquire about their suitability for her specific models before investing in one.

Switching audio interfaces

I'm using a Windows 11 Pro laptop, and would like to know how to hook up two audio interfaces on the same laptop. I use Cakewalk as my DAW, and I hooked up a Focusrite audio interface to record MIDI sounds from my electronic keyboard. I also use the VEGAS Pro video editor, and would like to hook up an external Sound Blaster soundcard to

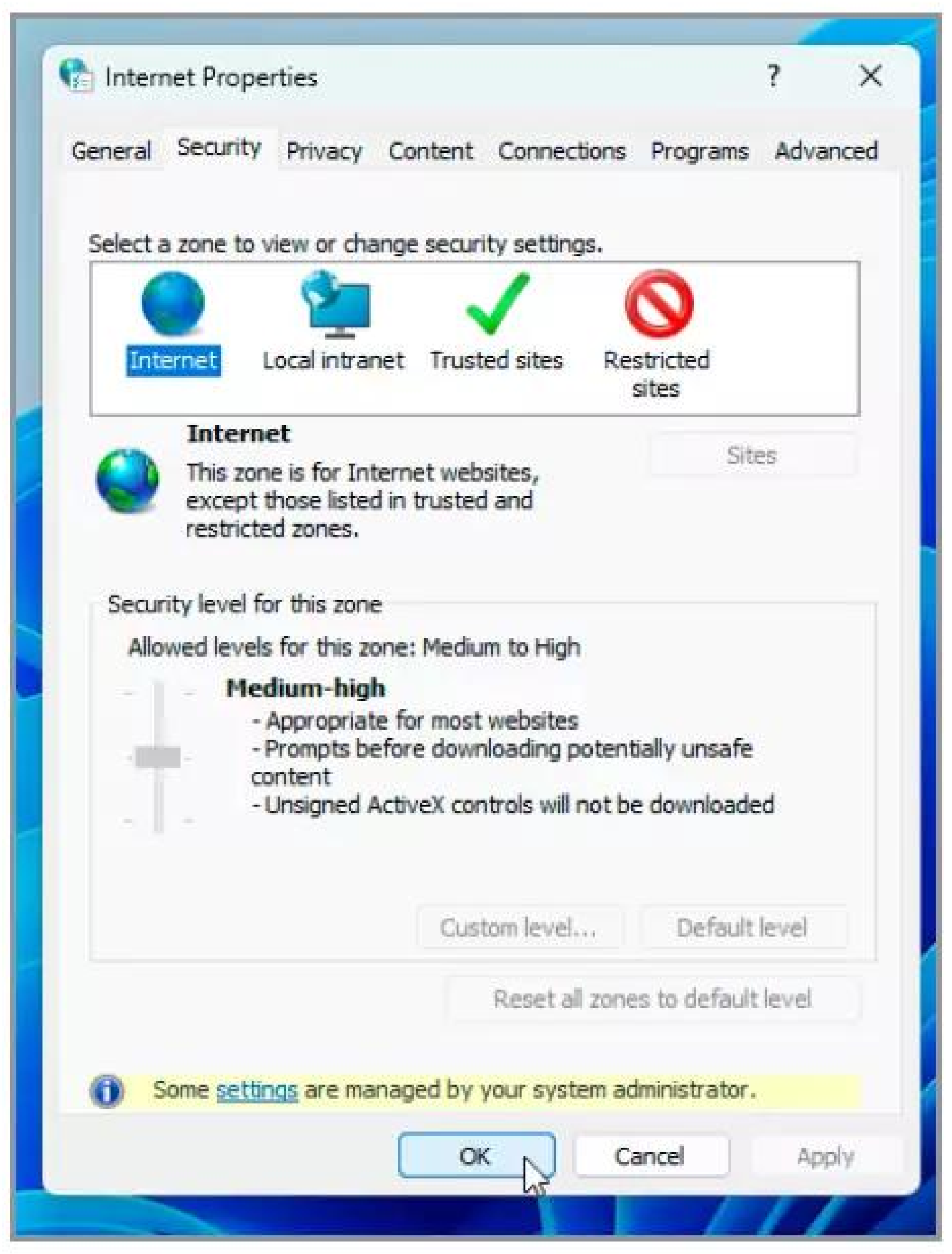
↘ submit your questions to: doctor@maximumpc.com allow me to edit videos with 5.1 surround sound. I need these audio interfaces to work independently, so when using VEGAS, I only need to use the Sound Blaster card, switching to the Focusrite card for recording MIDI. I've been told a mixer can do the trick. Can you help and perhaps suggest a mixer for such a task?**—George Criezis**

THE DOCTOR RESPONDS: We're going to assume you need a separate Sound Blaster soundcard, because your Focusrite model doesn't support 5.1 and 7.1 surround sound, as some higher-end models do. If it did, it would render a second audio interface redundant.

The good news is that you shouldn't need any mixer software. Both Focusrite and Sound Blaster cards should coexist alongside your laptop's default audio device, and you shouldn't need to manually switch between them, because both Cakewalk and VEGAS Pro allow you to choose a default audio interface.

If you were to set either device as your default audio device in Windows via Settings > System > Sound, then that device should be the default in programs where you've not specified which audio device to use. You'd need to configure the other program to use the non-default device.

In Cakewalk, this involves going to Edit > Preferences. Navigate to Audio > Devices to see if the Focusrite is present—if it is, make it the default for Input and Output. If it isn't, you may need to go to Audio > Playback and Recording to set Driver Mode to ASIO or WASAPI Shared first. Once set, Cakewalk will default to Focusrite, whether it's your default audio device or not. In VEGAS Pro, navigate to Options > Preferences > Audio device tab to set up your Sound Blaster card as the default when using that program.



Select a zone to view or change security settings.

Internet

This zone is for Internet websites, except those listed in trusted and restricted zones.

Security level for this zone

Allowed levels for this zone: Medium to High

Medium-high

- Appropriate for most websites
- Prompts before downloading potentially unsafe content
- Unsigned ActiveX controls will not be downloaded

Some settings are managed by your system administrator.

Your antivirus may block access to the Security tab of Internet Properties.

© MICROSOFT

Weird encryption

I've recently noticed some strange behavior on my PC. Any files I download in my web browser appear on my PC with a yellow padlock over the icon, regardless of where I save them to. I only noticed this when I attempted to share some images online—they ended up appearing to be corrupt, which I traced to files displaying this yellow padlock icon. The files open fine on my PC, but what's going on? **— Fred Mosby**

THE DOCTOR RESPONDS: It appears that Windows' default file encryption (EFS) has been enabled on your Downloads folder, Fred. It's a quirk of all Chromium-based browsers, including Chrome, Edge, and Vivaldi, that if the Downloads folder itself is set to be encrypted, then all files you download will be encrypted too, regardless of where you save them. The Doc suspects that Chromium downloads the file to Downloads—thus encrypting it—before it moves to your chosen destination. The same behavior isn't found in Firefox, where only files downloaded to Downloads are encrypted.

You can decrypt all files within the Downloads folder by right-clicking Downloads and choosing Properties. Click the Advanced button and clear 'Encrypt contents to secure data' before clicking OK twice. When prompted, allow Windows to decrypt all files and sub-folders.

However, any files you save outside the Downloads folder remain encrypted. You can manually remove the encryption by right-clicking one or more files in a folder and choosing Show More Options. You'll see a File Ownership sub-menu—expand this, and click Personal. You can apply this to a single file or all the files in a folder, but if they're scattered across multiple folders, you may need help tracking them all down.

To find out which files remain encrypted, open a Command Prompt and enter the following command:

```
cipher /u /n /h
```

This will produce a list of every encrypted file on your PC—you'll need to locate each one and decrypt it (or decrypt in bulk if more than one is encrypted). If the list is big, consider producing a text doc listing all the files:

```
cipher /u /n /h >
%UserProfile%\Documents\
encrypted.txt
```

From here, you can visit each folder and decrypt all the files inside. Good luck!

Network security glitch

I'm encountering several hurdles when attempting to connect to my NAS server's network share. While it appears under Network in File Explorer, double-clicking it results in being told I cannot access it. Windows' diagnostic reveals nothing. I can still connect to the drive by typing its IP address into the Address bar, but I'm told, 'You can't access this shared folder because your organization's security policies block unauthenticated guess access'. I also get a warning about potentially harmful files when I try to copy anything to or from the drive. Can I remove these messages? **—Andy Welch**

THE DOCTOR RESPONDS: The first problem can be resolved with a trip to Group Policy Editor (gpedit.msc) in Windows 10/11 Pro—navigate to Computer configuration > Administrative Templates > Network > Lanman Workstation and double-click 'Enable insecure guest logons', then set it to Enabled and click OK. Not only is guest browsing restored, you'll be able to access your server from its Network shortcut again. (If you're a Windows 10/11 Home user, you can apply the same fix via a trip to Registry Editor. Navigate to HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\LanmanWorkstation\Parameters, double-click the AllowInsecureGuestAuth value—create it as a DWORD Value if it's not present—and change it to 1.)

The second issue is a consequence of connecting to your NAS via its IP address, so it's technically solved by the fact that you can now connect via its NetBIOS name. However, the warning may remain if you log on through your server's IP address. If this is unavoidable, try removing the warning by adding your server's IP address (or your entire local network using wildcards like 192.168.0.*) to your local intranet. Visit https://superuser.com/questions/149056 for a discussion of the ways in which this can be done.

If you access the dialog only to find the options are grayed out with a warning that 'Some settings are managed by your system administrator', this may indicate a third-party tool—typically your antivirus software—may be blocking access for security reasons. Check its support documents or forum for a possible workaround, but ultimately, if you can connect through its NetBIOS name, do so.

THE ARC-FUL DODGER

Intel has gifted the GPU scene with a bona fide bargain, and it is glorious

IT'S BIT OF A STRETCH on that pun up there, but if we're honest, Intel has pulled off an epic heist with its latest budget GPU, worthy of Jack Dawkins himself.

Unlike its latest CPU escapades, the Arc B580 has caught the PC enthusiast community by surprise. Not only is it incredibly well positioned in the market, but it has also shattered performance expectations, all while outclassing pretty much every other budget to mid-range graphics card. It's fast becoming Intel's prodigal son for 2025.

We should have seen this coming, of course. Intel's first-gen line-up of its A700 series graphics cards equally represented an incredible-value proposition, thanks to solid 1080p and 1440p performance at a relatively minimal outlay. That had already ruffled the feathers of AMD and Nvidia in the process, although neither one did much about it other than a customary price cut. With an additional generation now under Intel's belt, we're starting to witness that impressive design philosophy mature into something truly special.

With all the hype surrounding the plucky little pixel-producing underdog, we had no choice but to push this thing to the limits ourselves; to grab it quick and shove it inside of our silver snuff box, before the *MPC* team were hauled off to Australia by boat, probably.

Still, that's exactly what we've done here today. If you're looking for an entry-level to mid-range system to sink your teeth into for the new year, and are willing to make a few tweaks to our component selections on the proceeding pages, you could be close to sidling up to a suitably stealthy $1,500 build that not only looks super, clean but also delivers on bang for the buck as it does so, demolishing 1440p gaming in the process.

This is the Intel Arc B580 build. Let's go. **–ZAK STOREY**

BENCHMARKS

Part		Price
CPU	Intel Core Ultra 5 245K	$280
Motherboard	ASRock Z890 Taichi Lite ATX	$400
CPU Cooler	Noctua NH-U9S chromax.black	$70
RAM	48GB (2x24GB) Corsair Dominator Titanium @ 8000 C38	$263
SSD 1	1TB Samsung 990 Evo Plus M.2 PCIe 4.0 SSD	$80
SSD 2	2TB Acer Predator GM7000 M.2 PCIe 4.0 SSD	$185
GPU	Intel Arc B580 Limited Edition 12GB	$250
Case	Hyte Y40 White/Black	$100
PSU	850W NZXT C850 80+ Gold	$110
Fans	1x NZXT F360 RGB Core, 1x NZXT F240 RGB Core	$110
Total Price		**$1,848**
Core Price*		$1,274

*"Core Price" refers to the key components generating performance (CPU, GPU Mobo, OS SSD, RAM), not accessories.

PRICES CORRECT AT THE TIME OF PUBLISHING

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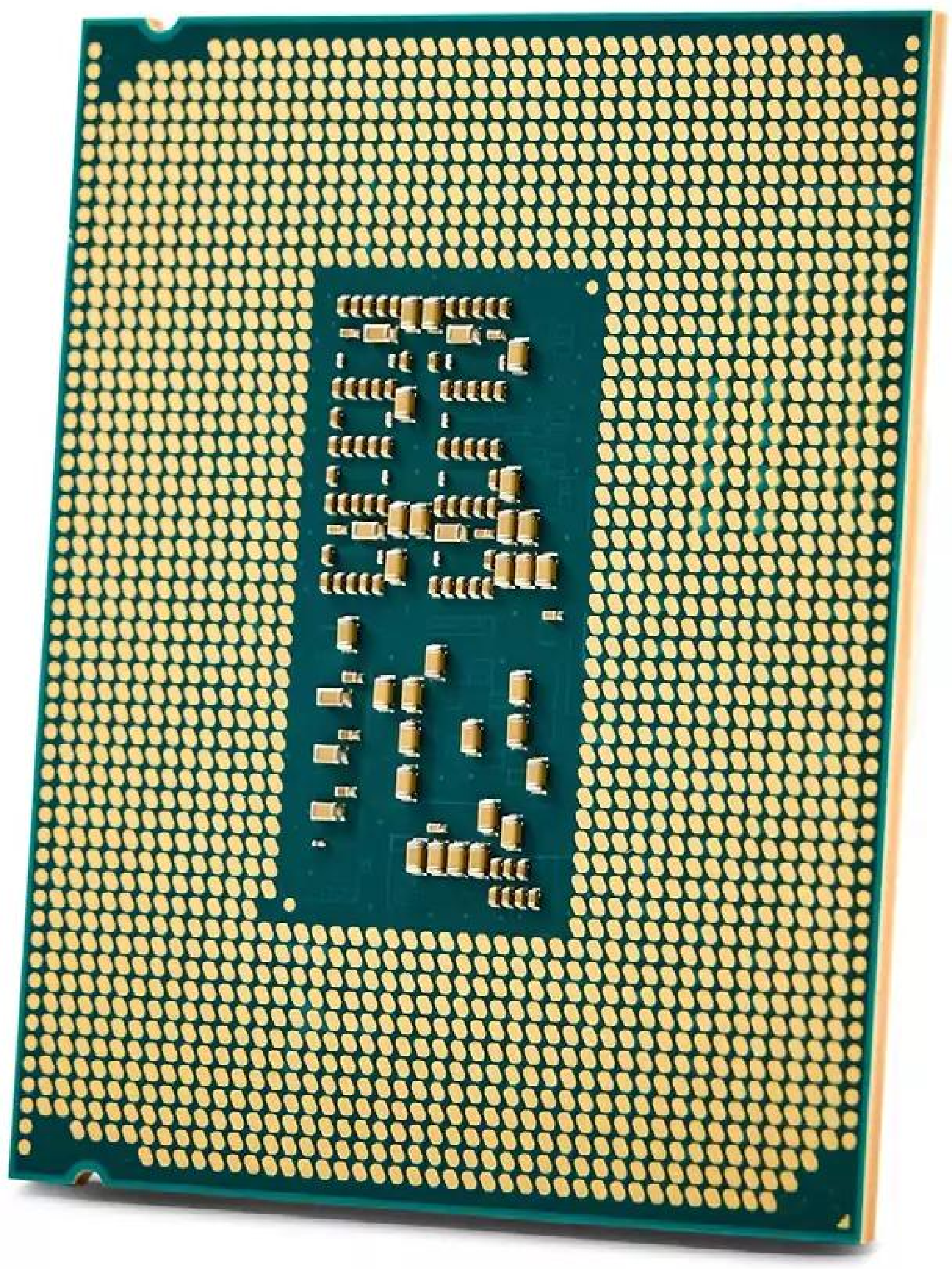


CPU $280

Intel Core Ultra 5 245K

14 cores and 14 threads—that's all you get these days when it comes to Team Blue's latest Core Ultra 5 chips. That's four threads short of what we used to have back in the day with the 14600K, and arguably one of the biggest changes with this gen of Intel processors. That's right: no more hyperthreading, not on the Core Ultra 5 or the Core Ultra 9. You're left with six performance cores, eight efficiency cores, a healthy heap of cache, and a relatively conservative 5.2GHz clock speed to tie it all together, dramatically pulling temperatures, power draw, and, er, performance down a notch—at least at launch, anyway.

Intel has facilitated all of this by shifting to a 3nm manufacturing process, courtesy of TSMC. That in and of itself is a massive departure for the company, as it typically manufactured its desktop processors solo, and the 14th series was no exception.

That's felt like an initial misstep for the company on the whole, too. The Core Ultra 200 series was met with some serious concern from the community, with poor performance across the board, massively inflated motherboard pricing, and generally poor sales. With developmental BIOS and chipset drivers, plus Windows struggling to allocate the resources at time of launch, it arguably performed worse than the last generation of chips.

The question remains: now we're a few months on and with the Core Ultra 5 cemented in the ecosystem, is that still the case? **www.intel.com**

Motherboard $400

ASRock Z890 Taichi Lite ATX

It's not just its poor performance that has held back the Core Ultra CPU series; its latest Z890 motherboards haven't helped the situation. Not only do these chips require a new, larger LGA 1851 socket, but their motherboards are also wildly expensive for not a huge amount of connectivity gain over the last generation.

Prices range all the way from $170 to $730 for a Z890 board, seriously muddying the waters when it comes to part selection. Our Taichi Lite that we've picked up here, despite looking like somewhat of a barebones solution with minimal armor, covers, or RGB displays of any kind sits right in the middle of the pack at $400, and comes with a healthy complement of connectivity as a result, albeit not a lot of style.

As standard, it features WiFi 7, 2.5 and 5 Gbps Ethernet, 2x Thunderbolt 4 Type C ports, 8 USB 3.2 ports (4x gen 2 and 4x gen 1), along with HDMI Out, Optical Out, Clear BIOS, and CMOS flashback buttons, plus a simple twin analog audio setup as well.

The board's also 'lite' on PCIe 5.0 support, with only a single PCIe 5 M.2 port, the single x16 GPU slot, and that's it. There are four additional PCIe 4.0 M.2 ports, but given one of the big selling points of this new series was additional PCIe 5.0 capacity, it does feel like something of a bum deal, given the price.

www.asrock.com

CPU Cooler $70

Noctua NH-U9S chromax.black

Even today, with designs that are three or four years old, there's very little out there that competes with the might of Noctua when it comes to fan cooling. Okay, a company will release the odd fan here and there that matches it on spec, but if you're looking for the ultimate air cooler, then Noctua's the place to go, year after year.

It's why we've picked up the NH-U9S for this little build of ours. Complete with a super-slim 95mm or 3.74-inch form factor and weighing 21.8 ounces or 618g, this thing absolutely delivers on performance. Combine that with a super-slick black design, a six-year warranty, top-tier airflow, a 150,000 hour mean time to failure, and a super-low 22.8 dB(A) at full tilt, and it's an easy pick to recommend for our Core Ultra 5 build. **www.noctua.com**

DOMINATOR
TITANIUM
DDR5
DOMINATOR
TITANIUM
DDR5

RAM $263

48GB (2x24GB) Corsair Dominator Titanium @ 8000 C38

This is a bit of a gluttonous pick for this rig, and you could easily drop down to a 32GB kit at 6,400 MT/s without necessarily impacting performance, if at all, all while halving the price.

Still, we were keen to see if higher memory frequencies dramatically improved the Core Ultra series' overall headline performance, and what better way to do that than with a funky 48GB kit at 8,000 MT/s, and with a C38 latency, to boot?

Corsair's Dominator Titanium series has always represented the best binned memory. It's premium, top-tier, and generally stable, and this kit's no different. With an elegant lightbar and a simple yet sophisticated design, it's ideal for our build. It's a shame about the cost (and that you can only buy it from Corsair's website directly at this capacity/speed). www.corsair.com

SAMSUNG
990
EVO
Plus
1TB

SSD 1 $80

1TB Samsung 990 Evo Plus M.2 PCIe 4.0 SSD

Bizarre budget SSDs are the name of the game on this one—another pick we're taking off the shelf to give a good run around and figure out how it drives. Samsung's Evo line has long had a reputation for being a fantastic budget solution for those looking for top-tier performance in the dedicated M.2 segment.

Weirdly, Samsung seems to have dropped the ball with the M.2 category, certainly as far as modern PCIe development is concerned. We're yet to see some true 5.0 x4 drives that deliver in any of the top-tier performance we'd expect from the company, sadly.

This 990 Evo Plus, however, is a bit of an odd one, as it's sort of a 5.0 drive, so far as it's capable of running on a 5.0 x2 setup. Obviously, the cases for that (particularly given PCIe as a standard is backwards compatible anyway) are limited, but it got us curious as to how well this would perform. Let's find out. **www.samsung.com**

SSD 2 $185

2TB Acer Predator GM7000 M.2 PCIe 4.0 SSD

Another lesser-known drive, Acer's Predator GM7000 is our secondary SSD of choice for this build, and an ideal additional storage solution. Again, a 4.0 setup first debuting late 2022, it features an interesting combination of 176-layer Micron TLC NAND, combined with an Innogrit IG5236 controller and 2GB of total DDR4 DRAM on the SSD to really help it zip along on those small-file size transfers.

It's getting a little long in the tooth these days, slowly approaching end of life, so if you can pick one of these up on offer as manufacturers try to shift warehouse stock, it's worth considering as a secondary option. **www.acer.com**

GPU $250

Intel Arc B580 Limited Edition 12GB

Here, we have the first Battlemage GPU from Intel, the B580, built off of the back of the Xe2 microarchitecture, and manufactured on TSMC's N5 lithography. It's quite the plucky graphics card.

Complete with a 190W TDP (or TBP for total board power), along with a PCIe 4.0 x8 setup, it combines a carefully honed mixture of ray tracing and AI accelerator componentry with more traditional rasterization hardware in what Intel calls its Xe cores. These have radically changed from the last generation. There are 20 featured on the B580 versus the 24 on the A580. Although that is a decrease, Intel has doubled the size of its internal vector engines while halving the amount of them (think of them like a core complex in a Ryzen chip). That reduces latency and allows the GPU to operate more efficiently.

Similar to its ethos with its most recent Core Ultra series, for Intel, this generation is not necessarily so much about brute-forcing a problem, but better allocating those resources. Compare the B580 to the A580, and die size is smaller, transistor count lower, and overall hardware is less. And yet, its clock speed is nearly a GHz higher, its DRAM has increased by 50 percent, and those internal core configurations favor improved latency over a 'more is better' attitude.

Combine that with a $250 price tag and enough performance to make even some 4K games quake in their boots, and it's more than likely that this thing's going to really shake the foundations of the entry-level PC-building community in the coming months. www.intel.com

PSU $110

850W NZXT C850 80+ Gold

Modern builds require modern power supplies, and although our Intel GPU of choice only requires a single 8-pin PCIe power to pull the juice, equipping yourself with a modern 2024 variant ATX 3.1 unit is always a good shout.

NZXT's C850 again fits that slot nicely, delivering some clean modular cables and a 12VHPWR to back it all up as well. It's quiet, 80+ gold, and relatively affordable at $110. Of course, the cables aren't sleeved, but really, that's not the end of the world.

All in all, our rig should be drawing an absolute maximum of around 500W from the wall, according to PC Part Picker, giving us 350W of wiggle room if we do decide to upgrade that GPU or CPU at any point in the future. Hint hint, Nvidia...**www.nzxt.com**

Fans $110

1x NZXT F360 RGB Core, 1x NZXT F240 RGB Core

Simple and sophisticated, as all good fans should be, NZXT's RGB Core Frames are just super easy to set up. You get a single cable splitter, four screws, and different sizes of frame for wherever you need it to fit. There's no fuss on the setup; just plug and play, and you're done.

Performance is pretty solid, and it connects seamlessly with NZXT Cam over an NZXT fan controller. Nice. www.nzxt.com

Case $100

Hyte Y40 White/Black

We've already looked at Hyte's Y40 chassis a few times; it's seriously slick, which is why it's stuck itself resolutely to our Blueprints section. Last time we played around with it, we went in a different direction with a more stealth-oriented build. This time, it's all about that RGB lighting, combining it with some of NZXT's shiniest illuminated fans to really make it pop.

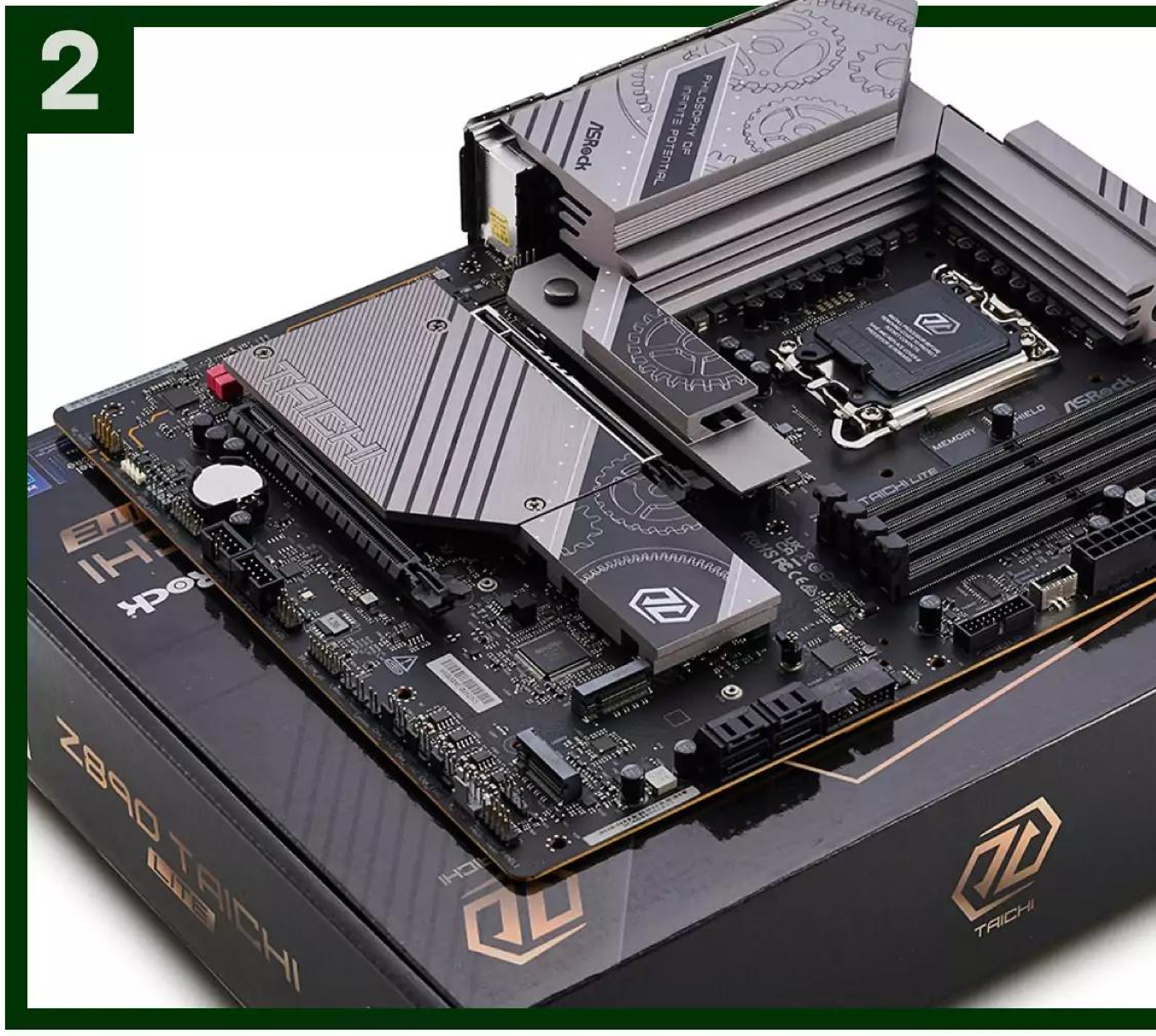
This is a dream to build in, albeit quite restrictive; you'll have a vertical graphics card, and you'll like it, but aside from that, it's easy to actually build in. Cable management is solid, the glass panels and internal layout are a dream, and it's available in a host of different color options. We've gone for the black and white 'Panda' edition, but you can get a complete white variant, the black version we had in our March 2024 issue Stealth build, and a more ostentatious black and red 'Black Cherry' version.

As for top line specs, there's support for up to a 360mm rad in the roof, 280mm in the side, and support for a 120mm fan in the rear and a 140mm fan in the bottom (a 120mm is included as standard). PSUs up to 8.82 inches and ATX motherboards sit in it fine (no joy for E-ATX, sadly), and GPUs can be up to 16.6 inches in length. All for $100. Stunning. **www.hyte.com**

BUILDING SIMPLICITY

1

2



LENDTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

A LONG TIME AGO, back in *Maximum PC*'s earlier days, PC builds were a lot more complex than they are today. The avenues that you could go down and the things you could do were more intricate, far more varied, and far more difficult.

There's almost a weird homogenization going on right now, mixed with no small amount of refinement. As this particular hobby space has grown from a relatively small community to the mammoth gargantuan thing that it has become in recent years, it has lost some of that charm and that complexity as it's done so.

Simply put, it's all about money. Not in a negative way; more people got into PC gaming; PC gaming blossomed; journalism, media, influencers, and companies all followed suit, and with more interest came more investment and easier access to information and expertise. That has led to modern-day products being so well built and thought-out that it's incredibly easy to build your first PC compared to, say, 2015, 2010, and certainly the early 2000s. It's not comparable, but similarly, cases and components follow rigid guidelines and structures, market trends, and categories. Finding a challenge or hardware that truly breaks the mold has become increasingly difficult.

This isn't us lamenting remorsefully how "things were better in the olden days." Not at all. Our PCs look radically different, and perform far more complex tasks at far higher levels than they ever have done, but when everything is good, when it's easy to set up and build a beautiful showcase PC on a budget, then well, it loses its sheen a touch.

Still, today, we're happy to report that this build is exactly that. If you're smart with your component picks, and decide that the Hyte Y40 is for you, what you're left with is a super-easy build process that'll leave you with a seriously clean-looking system, with very minimal outlay.

AND IT ALL STARTS WITH...

The chassis teardown. Step one **IMAGE 1** —you know it, you got it, and you love to see it. It's our most repeated step one in these builds, and with good reason. All good PC builds start with an analytical thought process. It begins with you sitting back and thinking about your parts list, what you want to put in your case, and where you want to place things.

Then, when your case turns up and you've got all the hardware ready to go, the next step is figuring out how that all fits together in real life. You could sit there for hours carefully building out individual 3D models of components in CAD programs beforehand, or alternatively, save yourself a lot of boring work and get stuck in physically instead.

Stripping back a chassis not only protects the panels and reduces the overall weight of the thing while you build in it, it'll also give you unfettered access to the interior and allow you to visualize what's going where, how you're going to place things, and what clearances you'll need to think about.

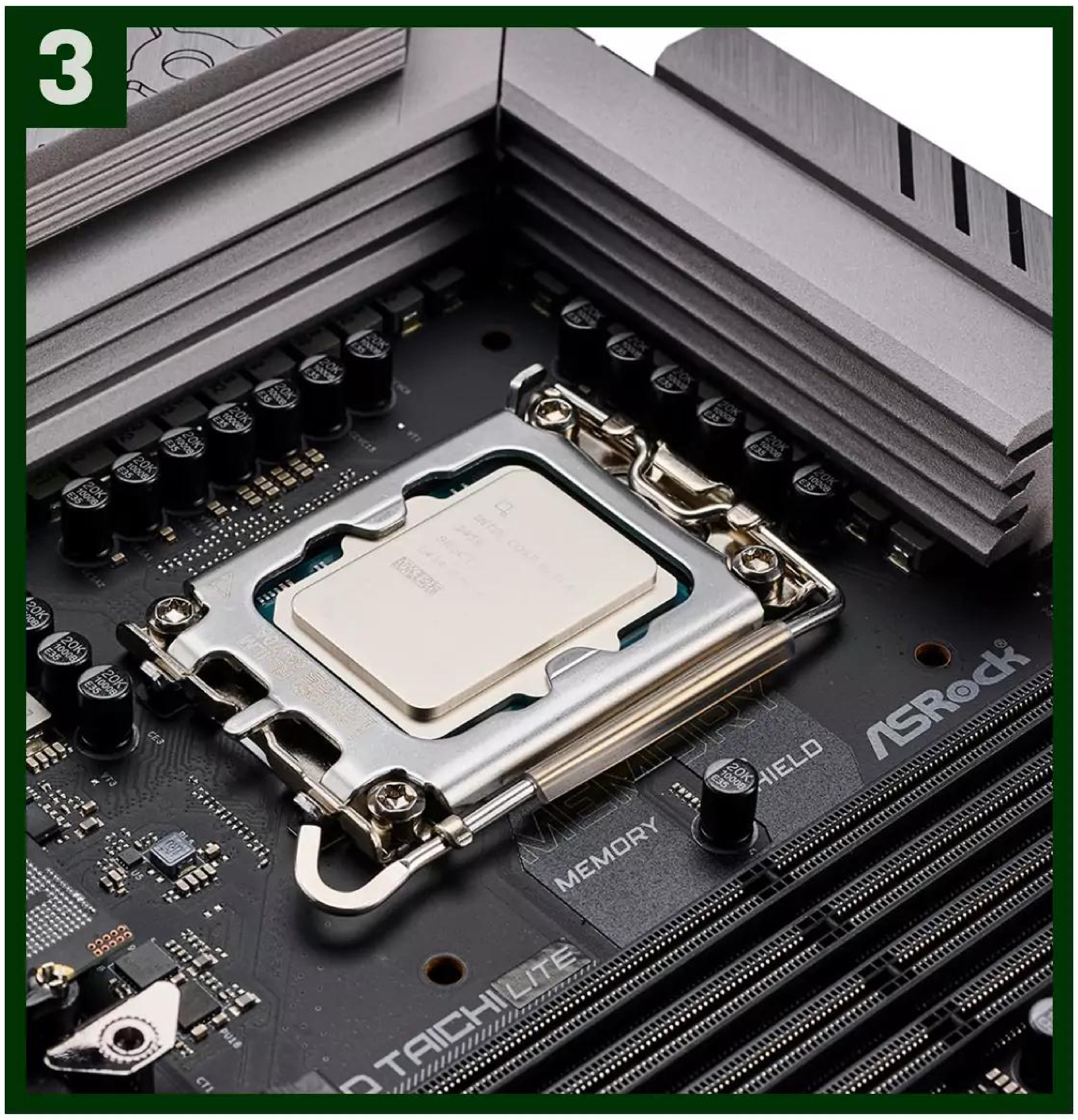
For this build, the panel removal is simple: rear panel off, side window off, roof popped off, dust filters out. After that, we decided to be a bit proactive, and not only remove the 120mm stock fan in the rear of the chassis, but also detach the PCIe riser from its mounting location. We're not removing it entirely, as it's a bit of a pain to secure back down to the top of the PSU cover, but instead, we're going to carefully move the motherboard around it, being sure not to scratch anything.

Also, you might have spotted that the front glass panel needs to stay stuck in. It's secured with Philips head screws, but you needn't worry about removing it, as not only does it add structural rigidity to the Y40, but it's unlikely you're going to be working around it that much either.

THERE IS NO FEAR IN THIS DOJO

We're aware that Tai Chi is a Chinese martial art, not a Japanese one for the *Karate Kid* fans out there, but honestly, this is one of those moments that genuinely slightly worried us in the build.

The last time we had an ASRock board in a build was 2015. Yeah, so a decade ago,



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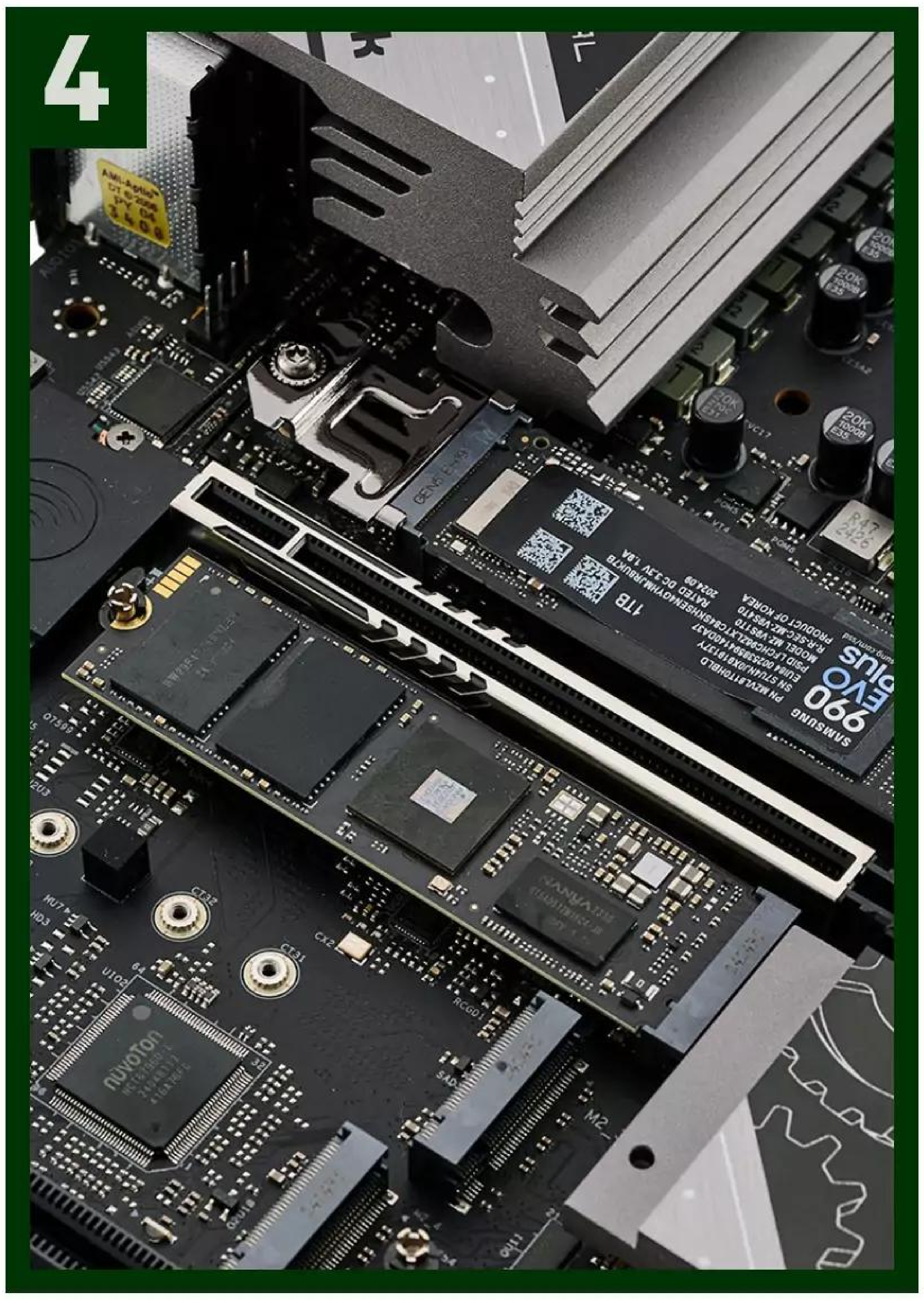

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not a small length of time. It's nice to get them back in, but it does mean we're not quite as in tune with the design language, regular features, and ethos that ASRock has been embodying over the last few years. Ways of accessing M.2 ports, for example, are slightly more convoluted compared to MSI, Asus, Gigabyte, and co. At least for now.

Still, as usual, straight away you're going to want to slap the mobo on top of the cardboard box it came in. We're going to prep this board as far as we can outside the chassis first just to make life a little easier, and the cardboard box is a lovely anti-static workbench to operate from. Word of caution: don't be like our photographer and pop it on top of the anti-static bag that it comes with (thanks, Olly). The exterior of the bag is conductive, so any static charge that's built up will discharge straight into your shiny new board. It likely won't cause any major issues, but it's better to be safe **STEP 2**.

First on the agenda is installing both our CPU and our twin SSDs. For those that don't know, Intel's Core Ultra shake-up hasn't changed much outside of the socket size, certainly when it comes to the chip install. Lift the retention arm up and out to the side, then raise the CPU bracket. Gently place your shiny new Core Ultra processor in the socket, making sure to align it with the golden triangles etched on both the CPU and the socket itself, then replace the CPU bracket and reattach with the retention arm **STEP 3**. Once that's done, the plastic cover will pop off (you can leave it in place throughout, so as not to damage the pins).

For our M.2s, we've got to remove two elements on the board, first the PCIe 5.0 heatsink. To do that, you're going to want to slide the metallic button to the right, and then, while holding that in place, carefully lift the heatsink up from the left-hand side. It should slide out to the right. Once that's done, you'll spot the M.2 connector underneath. Pop your M.2 drive into position, ensuring that it's aligned with the notch on the M.2 connector and on the drive itself. Lock it in place with the funky tiny plastic dial, then remove the plastic film on the thermal pad, and re-secure the heatsink.

Our secondary drive is a little easier to install. We're going to want to remove that big ol' block of metal with Taichi etched across it. Undo the three screws on the plate, then lift it up to find the M.2 slots underneath **STEP 4**. Again, it's simply a case of aligning the drive with the slot, pushing it into position, and reattaching the heatsink after you're done. If your drive does come with a heatsink already, and you've opted for a PCIe 4.0 solution, you could use the M.2 port on the bottom right-hand side of the board instead, but do be aware that it can conflict with your GPU (ie. physically get in the way) if you're not using a PCIe riser, like we are here for the graphics card.

IMPROVE YOUR PC-BUILDING LATENCY WITH THIS NEAT TRICK...

Next on the agenda, the DDR5. This is always a bit of a controversial choice when it comes to pre-install prep. On the one hand, installing RAM is super easy and quick to do. There's no real need, if we're honest, to do it right now; certainly not for a stock-cooled build. Nonetheless, for the sake of simplicity, installing it now just gets it out of the way, meaning you don't have to worry about it later.

If you're running two sticks like we are here, install them in alternative DIMM slots, as far away from the CPU socket as you can. This has been the de facto position for dual-channel kits for some time now, mostly as it helps to mitigate any potential CPU cooler compatibility problems, and doesn't impact performance to any great degree.

Find the slot, lift up the tabs on either end, then push your DRAM stick into position, ensuring you align the cutout in the stick with the notch in the slot itself. Remember, these notches are offset on purpose to ensure you correctly install the memory in the right orientation. It's also different from generation to generation, too, so you'll never be able to install a DDR4 RAM stick into a DDR5 motherboard **STEP 5**.

On to our heatsink now, and fortunately, Noctua's solutions are some of the easiest in the business to get set up. Point of warning: you absolutely need to install your CPU before you do this step, as

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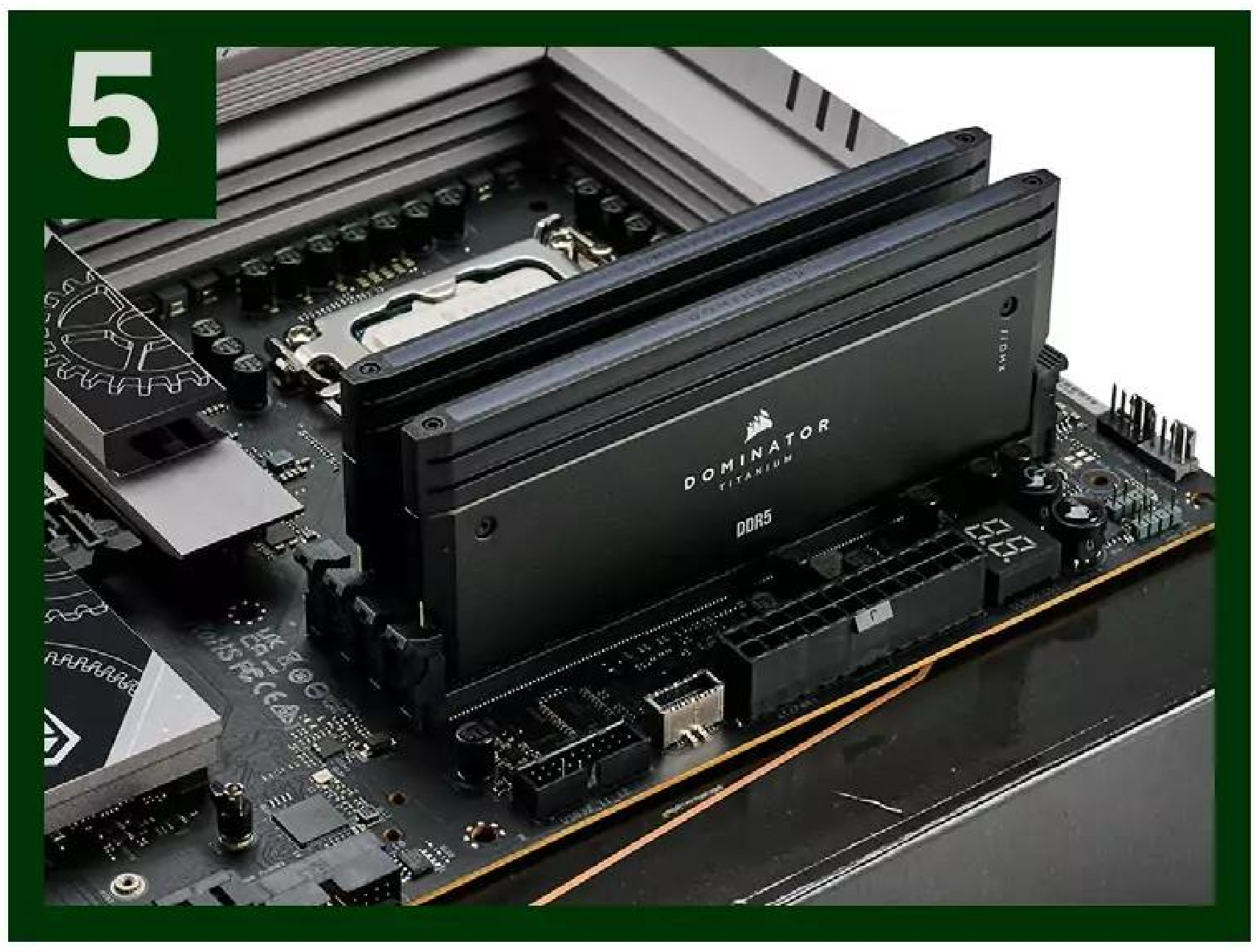

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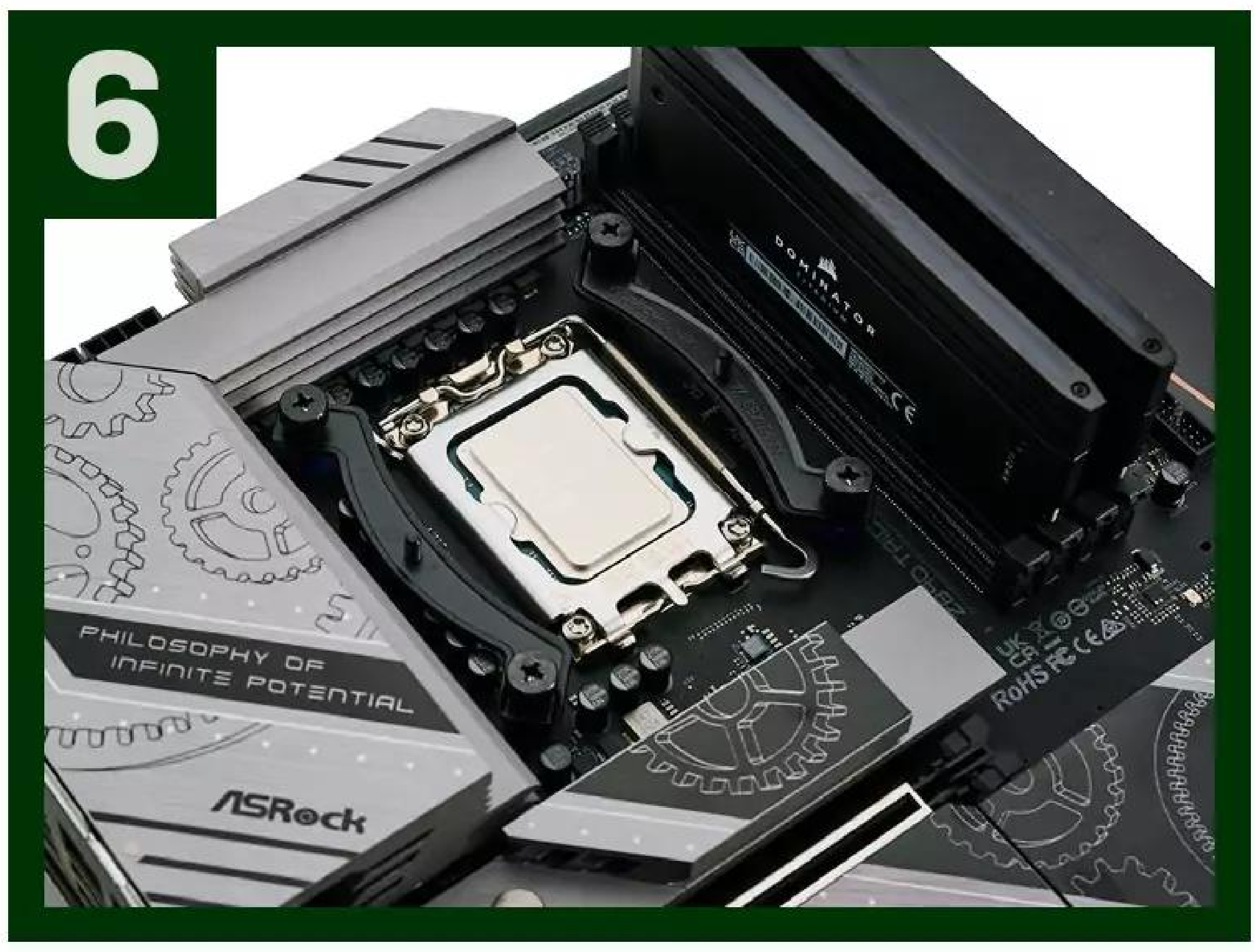

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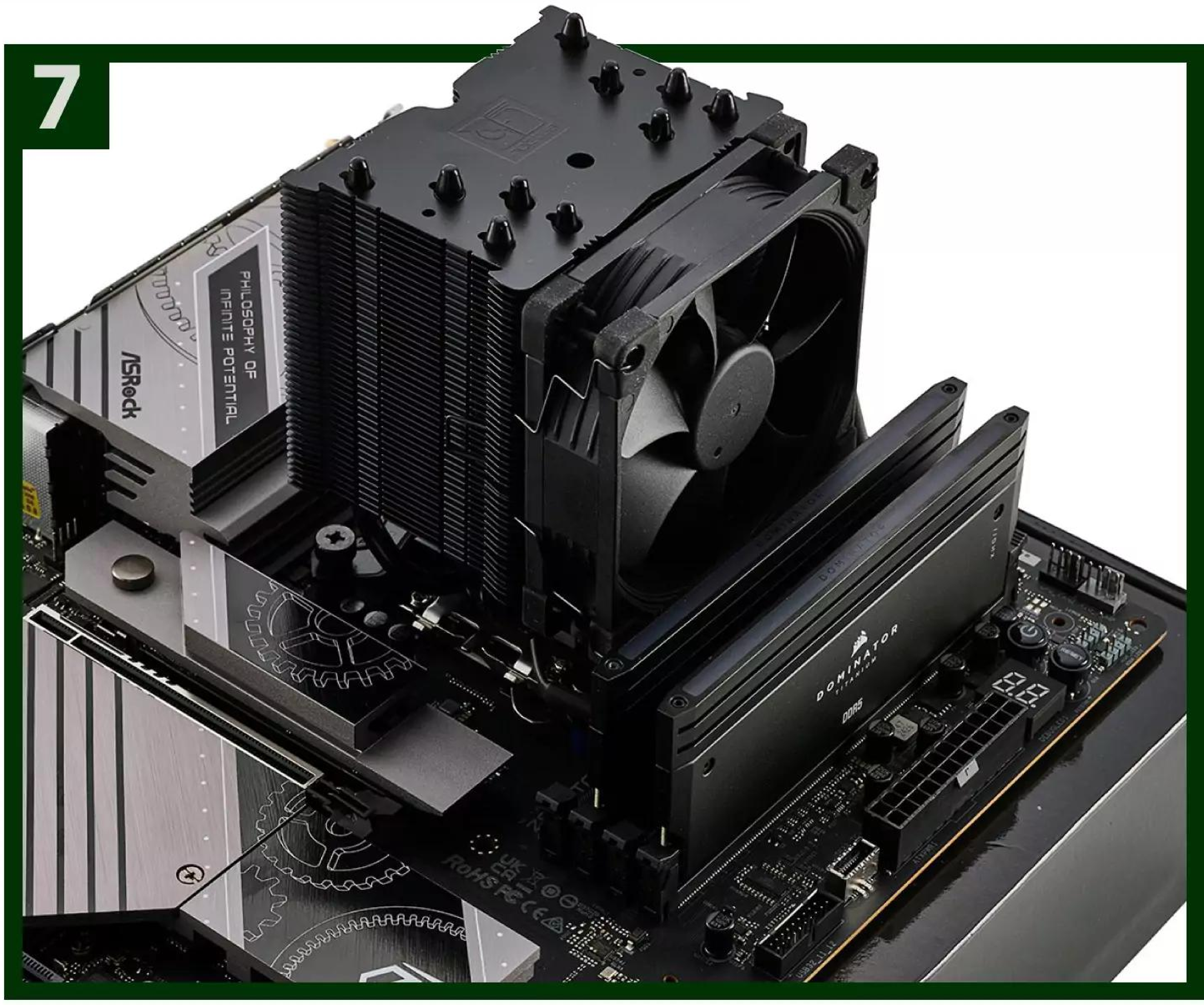


once the mounting hardware is in place, it's impossible to remove that retention arm, so make sure you've done that first. Grab your beautifully laid-out Noctua box, and find the correct mounting hardware for your socket. You'll need the bag of standoffs and brackets, plus an Intel backplate.

For our setup, take the backplate and install the mounting screws in the right position, securing them with the plastic locking spacers that Noctua includes. Place this under the motherboard through the holes in the PCB.

Once that's done, grab the correct spacers for the top CPU-socket side of the board. For any LGA1200 or 115X socket, that'll be the black ones; for LGA1851 and 1700, you'll need the blue ones. Place them over the bolts pocking out from the backplate, then take your mounting bars and position them on top, running top to bottom on the left and right-hand sides. There are indicators on the brackets themselves as to what orientation they should be facing, but you're looking to make a circle with them.

You can also orient them running horizontally if that's more suitable for your build, pulling cool air from the bottom of the chassis and exhausting out the top. For our build, we want to try and avoid using that heated air from the GPU. Once your brackets are in position, secure them with the four screws, and you'll be ready to get that cooler in place **STEP 6**.

THE ULTIMATE THERMAL PASTE GUIDE

Finally, we're on the last step for our motherboard prep, and we're actually going to fully install the cooler. Usually with big air towers, we wouldn't do this before the motherboard goes in the chassis itself. The main reason for this is that they're typically quite bulky, and there's not a huge amount of wiggle room in the case if you want to route cables or screw things in as an example. However, because the U9S is such a small air tower, it's not that big of a deal to do this now, and will save us some trouble later on down the line.

The first thing we're going to do is add a healthy dollop of the included thermal paste. The U9S comes with a tube of NT-H1, which has been *Maximum PC*'s unofficial thermal paste of choice for well over a decade at this point. It's a non-conductive paste with a nice, thick consistency to help it stick to the socket in all manner of wonderful and weird orientations. Plus, it drives some solid performance, or at least as much as thermal paste can do.

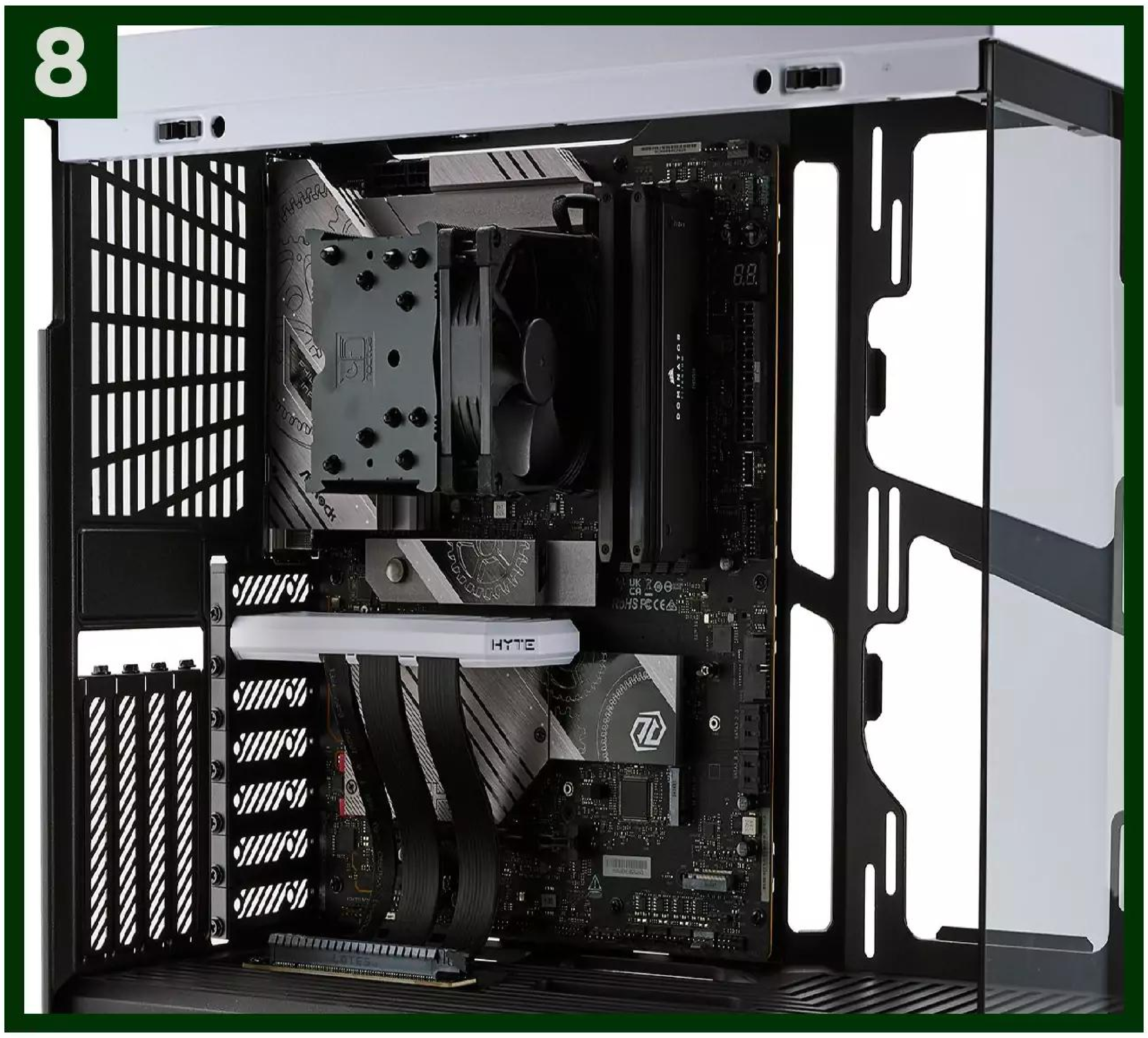
Because it's non-conductive, we don't need to worry about overapplying it to the CPU itself, as if it spills over, the only problem you'll have is a bit of cleaning up when you eventually remove the CPU heatsink. In fact, the additional paste also helps to ensure the TIM lasts longer by giving you a bit more leeway on it drying out. It's always better to apply too much than not enough. Three to four grains of rice running down the center of the CPU should be plenty, and once the heatsink is in position, it'll squish it out to the edges (although the bulk of that heat will be generated in the center, anyway).

With our paste in place, it's time to position the heatsink on top. We recommend removing the fan so you can access the screw on that side. Noctua includes a long screwdriver to help with this. The mounting screws are pre-installed to the tower, so it's just a case of lining it up with our brackets from earlier and carefully screwing each side down into place a bit at a time, until you reach the end of the thread. Then, re-attach the fan with its clips, and run the cable to the CPU fan header on the motherboard **STEP 7**.

BELIEVING THE HYTE

Now that our motherboard's all prepped and good to go, it's time to get this thing into the chassis. First, we're going to carefully tip the case over so it's lying on its side, then maneuver our motherboard into position, dodging the PCIe riser we removed earlier. Once it's in position above the included standoffs, it's time to secure it into position using the motherboard screws labeled in a bag in the accessories box located below the PSU cover.

These screws help to ground the motherboard to the chassis itself, which in turn will typically be connected to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the PSU, and that power supply to the wall, completing the grounding. So it's important that we secure the motherboard well here. On an ATX board like this, there'll be around nine screws you'll need to secure: three on the bottom, three along the top, and three running across the middle, with one annoyingly placed right under that M.2 heatsink (which you may have to remove temporarily to access).

After that, you'll need to install that PCIe riser cable into position. Depending on the location of your motherboard's topmost PCIe slot, you'll likely have to shift it down a position or so by removing one of the rear PCIe covers as well, then re-securing them both into position. The PCIe riser acts very similarly to a graphics card; you simply push it into the slot, and it'll click in place. Don't be worried about any latency; we've done a ton of testing on risers like these, and the only time we've ever had any issues is when we're using older standard risers with more modern standard cards (for instance, a 4.0 GPU on a 3.0 riser). In that case, even if there's plenty of bandwidth, we often find that you'll get errant coil whine from the graphics card under load, for whatever reason that may be **STEP 8**.

At this point in the build, to make our lives a little easier, we opted to install the CPU power now, even before we've got the PSU into position. Because it's a modular power supply, we can do this before installing the unit quite easily, so we won't have to fiddle around with cable management after we've installed the fans, either.

Our Taichi Lite requires twin 8-pin EPS cables, so we've grabbed those from the PSU box and installed them into the top-left power ports, before sliding them through the back of the case. We've also cable-tied them together to keep them a little tighter and neater before routing them down the case **STEP 9**.

At this point, it actually makes sense to pre-route the rest of the cables as well; we've done just that with the 24-pin and all of the front panel headers. Hyte's chassis has a similar block style front I/O pin design to the likes of NZXT, so find your front header on the motherboard, plug it in, and you're done. We've also installed the internal USBs here.

FRAMING THE SETUP

It's time to get those pesky fan frames into position properly; fortunately, this is one of the easier tasks we have on this build. Because the fan frames themselves are already pre-assembled, there are only four screws to worry about for each unit, holding them in place. We've gone ahead and installed a 240mm variant on the side here, utilizing it as an intake by making sure the rear fan guards are facing into the chassis itself. Although aesthetically not as great as having the fan blades facing outwards, this is far more thermally efficient. There is a single 120mm intake buried in the floor underneath the PSU cover (which does have sufficient cutouts for airflow passthrough), which does help to drive cool air into the chassis, but this provides far better intake as a result, reducing internal temps significantly.

In hindsight, it would have been better to have installed a 280mm setup here instead, just to maximize that cooling potential and give us a cleaner look on the overall rig. To install it, hold it in position, make sure you don't trap the proprietary cable, then secure it in place from the rear with the four included fan screws.

In our build, we're going to be using an NZXT RGB fan controller. You don't have to use this; instead, you can use the included splitter cable and plug directly into an aRGB header on the board, and run the PWM cable to a fan header instead. We've gone ahead and done the exact same with the top 360mm frame as well; however, in this case, we are in fact using it as an exhaust. Again, this is going to go into that fan controller, just so we can easily set up and configure the RGB in NZXT CAM **STEP 10**.

With the fans installed and our RGB controller in and connected, we moved on to finishing up the PSU by adding PCIe power and a SATA power cable to it as well (both for the fan controller and our 24-inch LED strip; more on that later), then connected our pre-threaded cables and pushed the PSU into position, before

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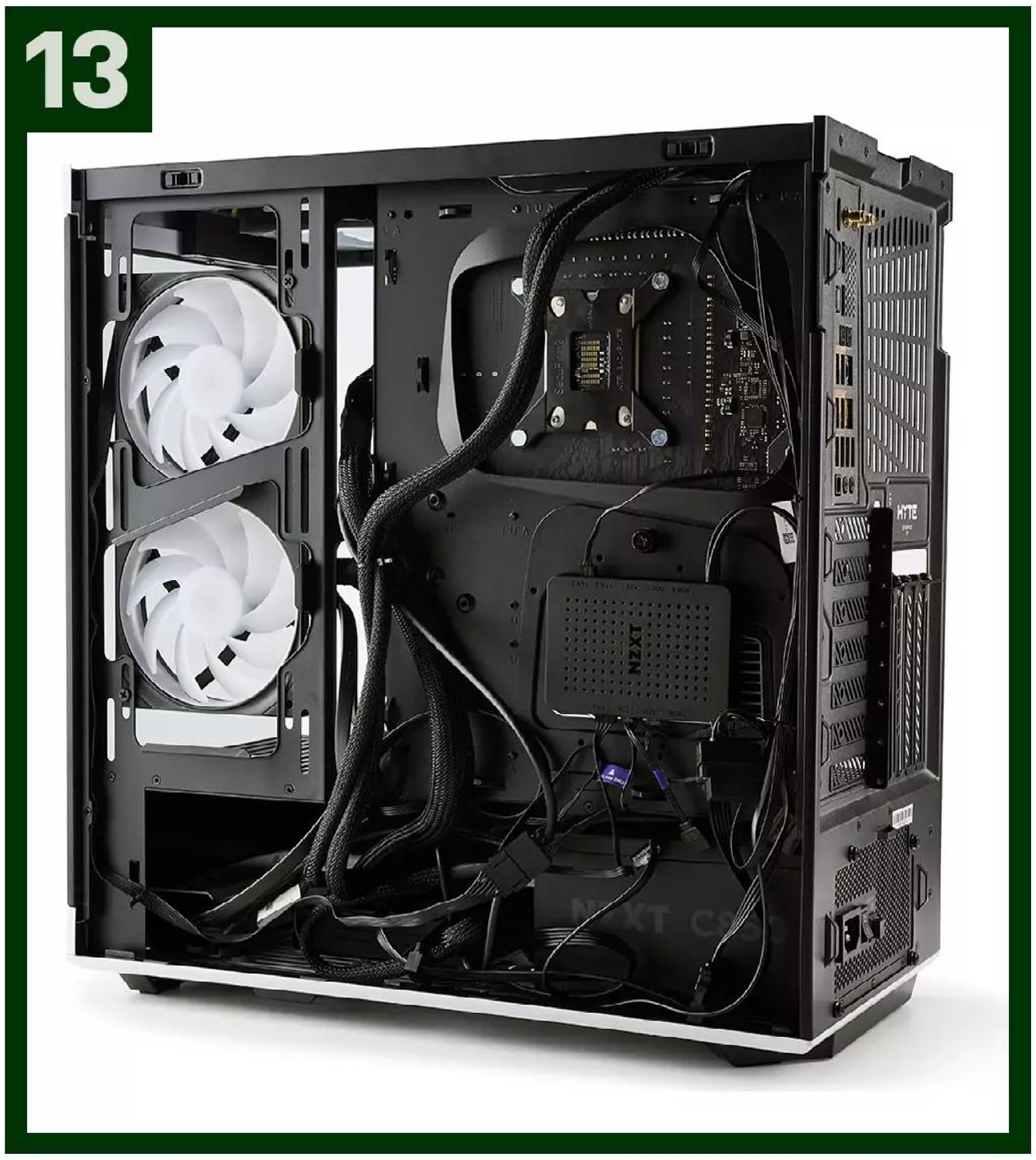

securing it from the rear.

It's worth trying to cable-manage this as best you can, as it's easy to have cables touch the fan blades on that 120mm in the bottom of the case **STEP 11**.

WHEN THINGS GO BOOM

We're getting close to the end of the build at this point. Next up is our trusty Intel Arc B580 graphics card, and with a vertical PCIe bracket, it's an absolute doddle to install. Remove the required PCIe covers from the rear of the chassis, then line the GPU up with the PCIe slot (we recommend getting your head low and looking at it from the bottom as you install it), and push it into the riser until it clicks into place. Secure it back into position with the screws you removed earlier from those PCIe covers, plug in your PCIe power that you've threaded through the bottom cutout in the PSU cover, and we're done **STEP 12**.

With our GPU in, it's time to give the back of the chassis a quick cable management tidy-up. Grab the cable ties that came with the chassis, and do your best to tie things together and down to the motherboard tray. There are a few cable tie-mounting locations dotted here and there to help out with that. We've bound the CPU and ATX power together, along with all the fans and cables on the right-hand side (including our SATA power for the 24-inch white LED strip). That's all going to the RGB fan controller, which is magnetized to the rear of the tray **STEP 13**. Word of warning: when managing your cable ties, don't tie them too tightly, and when you're cutting off the excess, give yourself about a quarter of an inch of spare plastic when you snip the rest off. Cut it too close to the latch, and it'll come loose **STEP 13**.

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It wouldn't be a *Maximum PC* build unless one thing went wrong somehow. This time, it wasn't shipping issues, but rather a faulty LED strip, causing the PSU to short and refuse to power on the build whatsoever. As the strip was working prior to being used in this build, it didn't come to mind as being an issue, either.

In this situation, diagnosing can be challenging. Fortunately, in our case, we had a few PSUs on standby that we could use to help troubleshoot the problem. The first thing we did was disconnect our C850 PSU and replace it with a C1500. This was massively overkill for the build, but perfect for diagnosing. We then unplugged the 24-pin from the motherboard and plugged our C1500's 24-pin instead. With that installed, simply hitting the power switch on the chassis should cause the PSU to kick in and boot the system. You'll get an error for no CPU or GPU power, but we're not worried about that at this point in time.

We did this, and no joy. Panicking and thinking that we'd bricked not only a C850, but also a C1500, we then decided to manually test if the PSUs were dead. You can do this by effectively bridging the 24-pin cable on the power supply. You can grab a bridge from Amazon for about $5 or so. Simply plug the bridge in, plug the power supply in at the wall, then turn it on using the button on the back of the PSU. This will force the PSU to kick in, and typically the fan will spin up. In the case of our C1500, it didn't (it was only later that we realized this was due to the Zero RPM mode being enabled). We tested the C850, however, and fortunately it did spin.

At this point, we know it's not the PSU, in which case the SATA devices were the next point to query. We unplugged the LED strip, plugged the C850 back in, and finally the system booted. If this had failed, we would have then had to go through every component, either reseating or unplugging items, until we identified the culprit causing the system to fail to boot. Usually, it's a peripheral causing the problem. If your motherboard has RGB and lights up, you're usually going to be okay **STEP 14**. Still, all was well in the end.

PLEASE SIR, I WANT SOME MORE

WE'D CALL THIS A SIMPLE BUILD, but that ending was far more dramatic than it needed to be. That is inherently one of the risks you take when re-utilizing older hardware in a system like this. To be clear, that LED strip is no longer available for sale, and is upward of eight years old; however, it has now been relegated to the *Maximum PC* retirement farm for legendarily reliable componentry (namely a drawer somewhere in our home office), never to be used again. Bless.

Power dramas aside, the build went incredibly smoothly, all things considered. The Hyte Y40 is becoming increasingly a favorite of ours; it combines slick, modern aesthetics and design motifs with a seriously easy build process that really does facilitate a whole host of hardware. It's not flawless; it lacks some key details which would really make it stand out of the crowd (rubber cable grommets would be lovely), but given what you're getting costs just $100 (including that PCIe riser), and it's available in all manner of colorways, it makes it a fine choice to house any ATX build. Airflow is also impressive, and it just really looks the part sat on your desk in your home office.

Going for the air tower as well feels like a bold decision, particularly as we've already done a Hyte Y40 build with the U12A cooler. Running a 360mm, or better yet (and perhaps more suited to this budget), a 280mm in that rear intake, would have perhaps been a bitter aesthetic fit for the overall feel of this thing. Yet, as builds go, we're happy with how this one turned out.

If you want to save some cash, however, without necessarily losing out on performance, there are some really cool hardware swaps you could do to bring the price down to around $1,520 or so, still with the same CPU and GPU clout as this build.

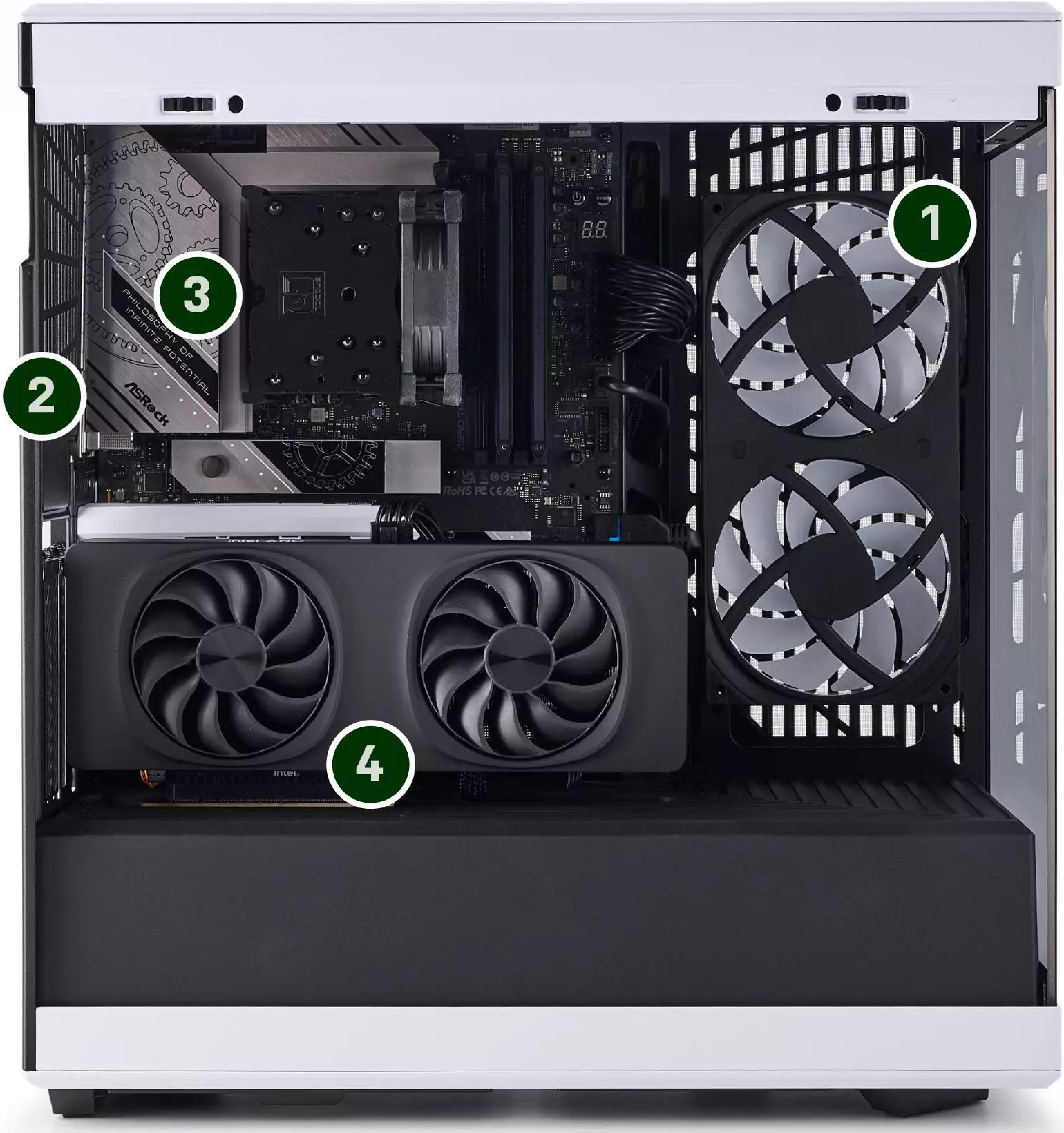
Swap out the Noctua NH-U9S for one of NZXT's latest 280mm Kraken Elite 2024 edition AIOs (mounting it in the side also means you don't have to grab an F240/280 RGB Core frame), shift to a Gigabyte Z890 Eagle WiFi7 ATX motherboard, drop the Corsair Dominator Titanium for a set of 32GB G.Skill Ripjaws M5 RGB @ 6400 C36, and switch the storage for a single Crucial T500 2TB, and you'll float just at the $1,520 mark nice and comfortably, without any pressing concerns (https://pcpartpicker.com/list/7fQxgn, prices correct at time of writing). You'll lose 12GB of DRAM, about 1.6GHz of memory frequency, 1TB of average storage, and really that's about it. That is, of course, if you can find a B580 GPU in stock.

1 A 280mm fan array in the front here would fill the space a lot better and improve airflow significantly for that Noctua air tower.

2 You could theoretically reinstall that rear 120mm stock fan to add some extra exhaust, but there's plenty in the roof anyway, and the mounting locations are pretty horrific due to the stylized grill.

3 ASRock's Z890 Taichi Lite board has plenty of connectivity, but very little style, and it's probably the first thing we'd change about this build, particularly given that $400 price tag.

4 When buying a GPU for the Y40, make sure it's no deeper than 3.1 inches. Any larger, and you'll start to stifle its access to airflow due to the windowed side panel.



OF ARROWS AND ARCS

HOW WE TEST

You know what we love at *Maximum PC*? Benchmarks, and lots of them. Datapoints to sink our teeth into, and really get to grips understanding the PCs and parts that we build with. It's the cornerstone of good, honest tech journalism, and something that's pivotal to our system builds, and for you to understand just how well or how poorly these PCs perform.

Each and every build in these hallowed pages gets put through the wringer in our new benchmarking suite. We push it through all manner of both synthetic and real-world tests while simultaneously monitoring temperatures, power draw, and more. Each test is executed a minimum of three times, and averages are taken from those results to give us the final scores and figures. If there's any wildly erroneous data, we scrutinize and retest until a consistent pattern appears.

We cover every segment of the rig, testing the CPU, SSDs, 4K, and 1080p gaming, along with a whole host of synthetic tests, and even AI computer performance, all to give us a better understanding of just how well our rig performs in everyday tasks.

THIS ISSUE'S ZERO POINT

This time around, our comparison PC is none other than the Console Killing PS5 Pro build from our December 2024 issue. We chose these rigs for two reasons, mainly the CPU and GPU combo in that one very closely mirrored our build here today; similarly, the price wasn't too far out, with the only major pricing difference coming predominantly from the RAM and motherboard picks; almost every other core component was similar in cost.

Our Zero Point features the Intel Core i5-14600K, an MSI MPG Z790i Edge WiFi motherboard, Noctua's NH-L965 chromax.black cooler, 32GB of Corsair Vengeance DDR5 @ 6000 C36, a 2TB Acer Predator GM7000 for the primary OS (the same as secondary drive today), and a Gigabyte Gaming OC RX 7600 XT with 16GB of VRAM. All of this is housed inside the Fractal Design Terra chassis and powered by a 600W BeQuiet! SFX-L 80+ Gold PSU.

The total price for the Zero Point build at time of writing is $1,523 (17.5 percent cheaper), with a core price of $1,115 (12.4 percent cheaper than our Arc build).

A MORE MATURE ARROW LAKE

You know, looking at the Core Ultra series a few months on now, with a few BIOS updates under its belt and plenty of Windows optimizations acquired, it does feel very much like a different chip, certainly compared to when we first dabbled with the Core Ultra 9. Now, don't get us wrong, it's still nowhere near what it needed to be, but it does start to feel like this was more a marketing slip-up and a need to hit a deadline that ultimately scuffed Intel on this launch than what you'd probably expect.

What do we mean by that? Well, these two systems are massively similar to one another in terms of internal hardware. The Core i5-14600K holds the same position as the Core Ultra 5 245K; the RX 7600 XT is AMD's entry-level GPU, as is the Arc B580 currently; and yet, the efficiency that our Dickensian build is showing is off the charts.

Take multi-core performance, for example—in both Cinebench and Geekbench, it managed increases of 13 percent compared to the 14600K. That's not a lot, but when you consider that it lacks hyper-threading on those performance cores, and is competing with a chip that has 20 threads to its 14, the efficiency per core, or per thread really, shoots up by an average of 60 percent across both tests. Single-core similarly sees an eight to 10 percent performance increase.

That's further compounded when you look at how those two systems draw power, because despite the Core Ultra 5 not exactly blowing us away with its lower temperatures (it's still maxing out at 94.0 C across all tests), the overall power draw, even with a second SSD, more fans, higher speed memory, and a bigger motherboard—well, it's a drop of 90W near enough. 20 percent all in all. Now yes, AMD's GPUs aren't exactly the most efficient, but that is a radical drop in peak power draw between the two.

IT'S NOT ALL RAINBOWS

Here's the thing, though: it's still not quite right. Although those very mainstream and well-known benchmarks (including 3D Mark's CPU Profile) showcase some seriously impressive scores for the latest generation of Intel processors, in-game it's a whole other matter. Now, to be clear, we are effectively comparing two very different GPUs here as well. First and foremost, the B580 does incredibly well in our benchmark suite currently, pipping the 7600 XT to the post at both 1080p and 4K (and 4K quite admirably at that). What's wild is that if you look at the early results and reviews of the B580, on an identical test bed, the 7600 XT often pulls out slightly ahead, certainly at 1080p Ultra.

In our case, the B580 had the edge. That would suggest that like for like, the Core Ultra 5 245K is actually helping to deliver greater in-game performance at 1080p than we first gave it credit for back on launch. Yet, there are some really intriguing results that stand out, pulling that figure up.

Cyberpunk, for instance, without AI upscaling tech, landed a phenomenal 39.4fps versus the RX 7600 XT's 24.7—so much higher, in fact, that we triple-checked the settings, re-ran the tests an additional three times, and still ended up with that score. In *Final Fantasy XIV*, equally the B580 burst up to 140fps, versus the 127 on our AMD console rig. Lastly, we of course have the fall on the AI upscaling run, where despite Intel's XeSS's best attempt, it could only manage 71.4fps without AI frame generation, although that is still admirable, all things considered, as the 7600 XT did have that advantage during the testing runs (and to be clear, you can run this card under FSR with AI frame gen as well).

4K results similarly saw the B580 beat out the 7600 XT in *Cyberpunk* stock, as well as a massive 22fps difference in *Final Fantasy XIV*, and even the *Cyberpunk* AI upscaling score was far tighter than before, with the B580 sailing past the 7600 XT, despite its AI frame gen advantage.

A DYNAMIC SHIFT

This is all curious for a number of reasons; these wild swings indicate that perhaps Intel is onto something here with how it reorganized and redeveloped both its graphics and CPU architectures—a 'more is less' approach. The B580 has fewer Xe cores, but their vector engines have doubled in size. The Core Ultra series has lost hyperthreading, yet its multi-core performance per thread has skyrocketed in a very similar manner.

The two seem to be trading architectural similarities, and although it's taking time to embed and fully mature, what you're left with are massive wins in very specific scenarios, combined with ridiculously low power draw and high levels of efficiency. The problem is that those wins aren't across every title, nor across every application, nor in every test, and it's an incredibly difficult thing to communicate to market, to get across to the average Joe, or even us professionals. But our tests certainly left us impressed.

SYSTEM BENCHMARKS

For our system testing, we use a multitude of separate benchmarks. For our CPU tests, these include Cinebench 2024 and Geekbench 6.3.0. All results are indexes in this case. Multicore per thread is achieved by dividing the total multicore scores by the number of threads on the CPU. For storage testing, we're taking advantage of CrystalDiskMark 8.0.5—the best scores are in bold, and all results are reported in MB/s. Throughout our entire benchmarking process, we test each system with a power meter plug running, and the latest version of HWMonitor installed and up as well. This allows us to report on the maximum power draw and temperatures seen over the entire benchmarking process.

CPU PERFORMANCE CINEBENCH 2024 & GEEKBENCH

	ZERO-POINT	
Cinebench 2024 Multi-Core	1,151	1,303 (13.2%)
Cinebench 2024 Multi-Core Per Thread	58	93 (60.3%)
Cinebench 2024 Single-Core	120	132 (10.0%)
Geekbench 6 Multi-Core	16,392	18,527 (13.0%)
Geekbench 6 Multi-Core Per Thread	819.6	1,323.36 (61.5%)
Geekbench 6 Single-Core	2,832	3,059 (8.0%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

STORAGE PERFORMANCE CRYSTALDISKMARK 8.0.5

	ZERO-POINT	
C: Sequential Read/Write Q8	**7,129** / **6,681**	6,928 / 5,776
C: Random 4K Read/Write Q1	**92.12** / 280.88	79.03 / **298.22**
D: Sequential Read/Write Q8	N / A	6,985 / 6,718
D: Random 4K Read/Write Q1	N / A	80.93 / 269.33

POWER DRAW & TEMPERATURE HWMONITOR & DEDICATED POWER METER

	ZERO-POINT	
Max CPU Temperature	100.0 C	94.0 C (6.0%)
Max GPU Temperature	66.1 C	72.0 C (-8.9%)
Max System Power Draw	458.9 W	369.5 W (19.5%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

GAMING BENCHMARKS

Game tests are performed on Ray Tracing Ultra *(Cyberpunk)*, Ultra *(Far Cry 6)*, Maximum *(Final Fantasy: XIV Dawntrail)*, and Ultra *(Total War: Warhammer 3)* graphics presets. Three runs are performed per title, per resolution. *Cyberpunk* is always tested with ray tracing enabled regardless. Under its second set of conditions, DLSS/FSR/XeSS is enabled in *Cyberpunk* dependent on GPU manufacturer, with upscaling preset set Quality. Nvidia cards also have AI Frame Generation enabled. *FF XIV: Dawntrail* is utilizing FSR across the board regardless of GPU, with LOD on Distant Objects enabled, and dynamic resolution disabled. *Far Cry 6* is tested with DXR disabled, and the HD Texture pack downloaded and enabled.

1080P PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	24.7 / 21.2	**39.4** / **34.4**
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	**85.4** / **73.1**	71.4 / 61.4
Far Cry 6 (Avg/Min FPS)	**115.3** / **95.0**	113.3 / 82.0
Final Fantasy XIV: Dawntrail (Avg/Min FPS)	127.1 / **86.0**	**139.6** / 50.7
Total War: Warhammer 3 (Avg/Min FPS)	88.7 / 69.3	**90.6** / **70.3**

1080P PERFORMANCE

	ZERO-POINT	
1080p Titles Aggregate (Average FPS)	88.23	90.85 (3.0%)
1080p Titles Aggregate (Minimum FPS)	68.93	59.77 (-13.3%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4K PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	7.0 / 6.1	**11.9** / **10.5**
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	25.6 / 22.6	**26.9** / **23.6**
Far Cry 6 (Avg/Min FPS)	46.7 / **42.7**	**52.0** / 40.7
Final Fantasy XIV: Dawntrail (Avg/Min FPS)	34.4 / 22.0	**56.5** / **36.3**
Total War: Warhammer 3 (Avg/Min FPS)	27.8 / 19.3	**32.0** / **23.0**

4K PERFORMANCE

	ZERO-POINT	
4K Titles Aggregate (Average FPS)	28.29	35.86 (26.8%)
4K Titles Aggregate (Minimum FPS)	22.55	26.83 (19.0%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

SYNTHETIC GAMING BENCHMARKS

We're using 3DMark's latest Speed Way, Steel Nomad, Night Raid, and CPU Profile tests. Speed Way represents a DX12 title at 1440p, with ray-tracing elements, Steel Nomad is DX12 4K without ray tracing, and Night Raid (DX12) is designed with integrated GPUs in mind at 1080p. CPU Profile acts as an additional CPU benchmark (reporting on max thread output only), with specific gaming workloads prioritized. Each synthetic test is run three times, and indexes are reported on.

3DMARK PERFORMANCE

	ZERO-POINT	
Speed Way (DX12 + RTX @ 1440p)	2,063	2,466 (19.5%)
Steel Nomad (DX12 @ 4K)	2,348	3,080 (31.2%)
Night Raid (DX12 @ 1080p)	66,064	76,768 (16.2%)
CPU Profile	9,560	11,908 (24.6%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

AI INFERENCE BENCHMARKS

For our AI testing, we use UL Procyon's Professional Benchmark Suite. We focus on its AI Computer Vision (which gives us a gauge on how our systems operate when dealing with inference engine tasks), and AI Image Generation benchmarks. For Computer Vision, we report on the total inferences performed, the average inference time, plus the Index score across all tests. The Index score is more valuable, as it's the time taken between inferences that indicates performance. We run all tests on AI Vision using Float16 precision. We test both the CPU and the GPU under Microsoft's ML API.

For Image Generation, we test under Stable Diffusion 1.5 (Float16 precision), using all engines available. However for comparison, we only include scores from the same engine. We report on the Index score, the time taken, and the image generation speed. All results are averaged across all tests. Best scores, where appropriate, are in bold.

AI COMPUTER VISION PERFORMANCE

	ZERO-POINT	
Microsoft ML API CPU (Index)	47	58 (23.4%)
Microsoft ML API GPU (Index)	646	1,198 (85.4%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Microsoft ML API CPU (Total Inferences)	10,391	12,746
Microsoft ML API CPU (Average Inference Time)	777.02 ms	**671.24** ms
Microsoft ML API GPU (Total Inferences)	97,897	165,954
Microsoft ML API GPU (Average Inference Time)	23.60 ms	**20.83** ms

AI IMAGE GENERATION PERFORMANCE

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Index)	736	906 (23.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Time Taken)	135.745 seconds	**110.345** seconds
Stable Diffusion 1.5 ONNX (Image Generation Speed)	8.484 seconds/image	**6.879** seconds/image

HAVE WE REACHED MAXIMUM PC?

Has the desktop reached the point where it can get no better? *Ian Evenden* looks ahead

Bought a new PC recently? Did you wonder why it was so similar to the one you'd upgraded from? Perhaps you researched components, and realized they're just improved versions of the ones you bought 10 years ago. We've all been there.

PCs have improved in the last decade or so, with increases in clock speeds, transistor counts, and power consumption, but there's been no great leap; just hype about AI (and new architecture, thanks to Qualcomm). A PC you build today may look similar to one you've built previously, with no advances in compact cases; just more USB-C ports that do slightly different things.

There are some interesting technologies on the horizon, however, such as photonic computing, increased cloud streaming, and software updates that attempt to take advantage of improved hardware. So where is the PC going, is there a way off the plateau we find ourselves on, and will we need to keep upgrading our machines in the future?

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THE ELEPHANT IN THE ROOM, if we're going to argue that nothing significant has happened to PCs in the last few years, is Snapdragon. The arrival of ARM-based chips in the PC, following their successes in cellphones, tablets, Macs, and embedded systems, poses an obvious question: is x86 dead?

Intel has repeatedly said no. AMD would likely be inclined that way, too. Arrow Lake, the Core Ultra Series 2 processors from Intel, are very unlikely to be the last of their line. But the rise of a competitor almost 50 years after the release of the 8086 is a highly significant event. So far, Snapdragon X hasn't made it out of laptop form, but we only have to look over the fence at Apple's recent range of desktops to see how an ARM-based design can perform when placed under a decent cooling system. The fact that the chips can also operate fine with nothing more than a fancy heatsink attached (in the passively cooled MacBook Air and iPad Pro) is a bonus that means it's possible to buy a tablet that's more powerful than you'll ever be able to make use of. We look forward to Apple's attempts to put one of its M chips in an iPhone.

What's more interesting is that the M4 is built on a 3nm process from TSMC, similar to that used by Arrow Lake's compute tile. The rest of Arrow Lake, which comes in four parts, with GPU, I/O, and SoC tiles in addition to the one with the processor cores, is built on 5nm and 7nm nodes, but all by the Taiwanese foundry. Intel used its own Intel 4 (7nm) process for AL's predecessor Meteor Lake, but farmed production of the Core Ultra 2 chips out while it works on its own 2nm node, perhaps ready for Panther Lake in 2025.

CENTRAL PROCESSING

Intel remains committed to x86, having terminated its RISC-V development program at the beginning of 2023, and even dumping the x86S project, which would have simplified the processor architecture, slicing away legacy instructions, such as 16-bit addressing, and allowing it to start directly in 64-bit mode, rather than having to step up through legacy modes as it boots. Exactly why the company did this—it seems like an obvious step, as we rarely run 16-bit software on our Core i9 chips, and could probably do it perfectly well in an emulator if needed—is unclear, but Intel has thrown its weight behind traditional x86 with the creation of "...the x86 Ecosystem Advisory Group in collaboration with AMD and other industry leaders," according to a statement. "This initiative reinforces our dedication to securing a strong future for x86, building on decades of software compatibility," the spokesperson continued. "While we have pivoted away from the x86S initiative, our focus remains on driving innovation and collaboration within the x86 ecosystem."

It's important to remember that x86 is an ISA, or Instruction Set Architecture (if you thought it meant Industry Standard Architecture, then get back to your IBM AT or compatible) that defines how software interacts with the CPU. This means processors we class as 'x86' can be wildly different in the way they're laid out and stamped into silicon wafers, but can execute the same instructions. New instructions are added to the set all the time, as we saw with the Pentium MMX (1997), which began the introduction of SIMD (single instruction, multiple data) commands that improved parallel processing, and was built on in subsequent releases, culminating in AVX-512 that first appeared in 2016, but was removed from 12th-gen Core chips in favor of the Xeon server chips, and is implemented in AMD's Zen 5.

Recent generations of CPUs have seen some changes, with Intel and AMD integrating tile-based architectures into their chips, and Intel moving to an asymmetric core mix with Performance and Efficiency cores that mirror the big.LITTLE configuration seen in the ARM chips that run your smartphone. The advent of multiple cores in home CPUs, rather than dual-processor boards or server chips, tells us much about the way the race for increased processing power is being run. We already have a second processor in our PCs that is dedicated to graphics—

Surface devices might not be the ideal thing for gaming, but with cloud streaming, they can be.

© MICROSOFT

there was an attempt to have another one purely for processing physical interactions in games (PhysX, bought by Nvidia in 2008), and the idea of a math coprocessor (aka, a floating-point unit or FPU, or confusingly, a numeric processing unit or NPU) was a thing back in the days of the 80386 CPU.

What's different about the modern CPU landscape, however, is the way that single-core performance continues to be important at the same time as multi-core. Game engines, in particular, aren't easily parallelizable, and the law of diminishing returns operates as surely as Moore's Law (which says that the number of transistors in an integrated circuit doubles about every 18-24 months). Many cores can help if a job can be split into neat pieces and spread out, such as tile-based rendering, in which each core renders an eighth or 16th of a scene at the same time, but can't help if you're trying to do a long list of actions in a row. If your wife is pregnant, acquiring more wives does not get you a baby faster, and many computing algorithms rely on the ability to do a lot of things very quickly, one after the other.

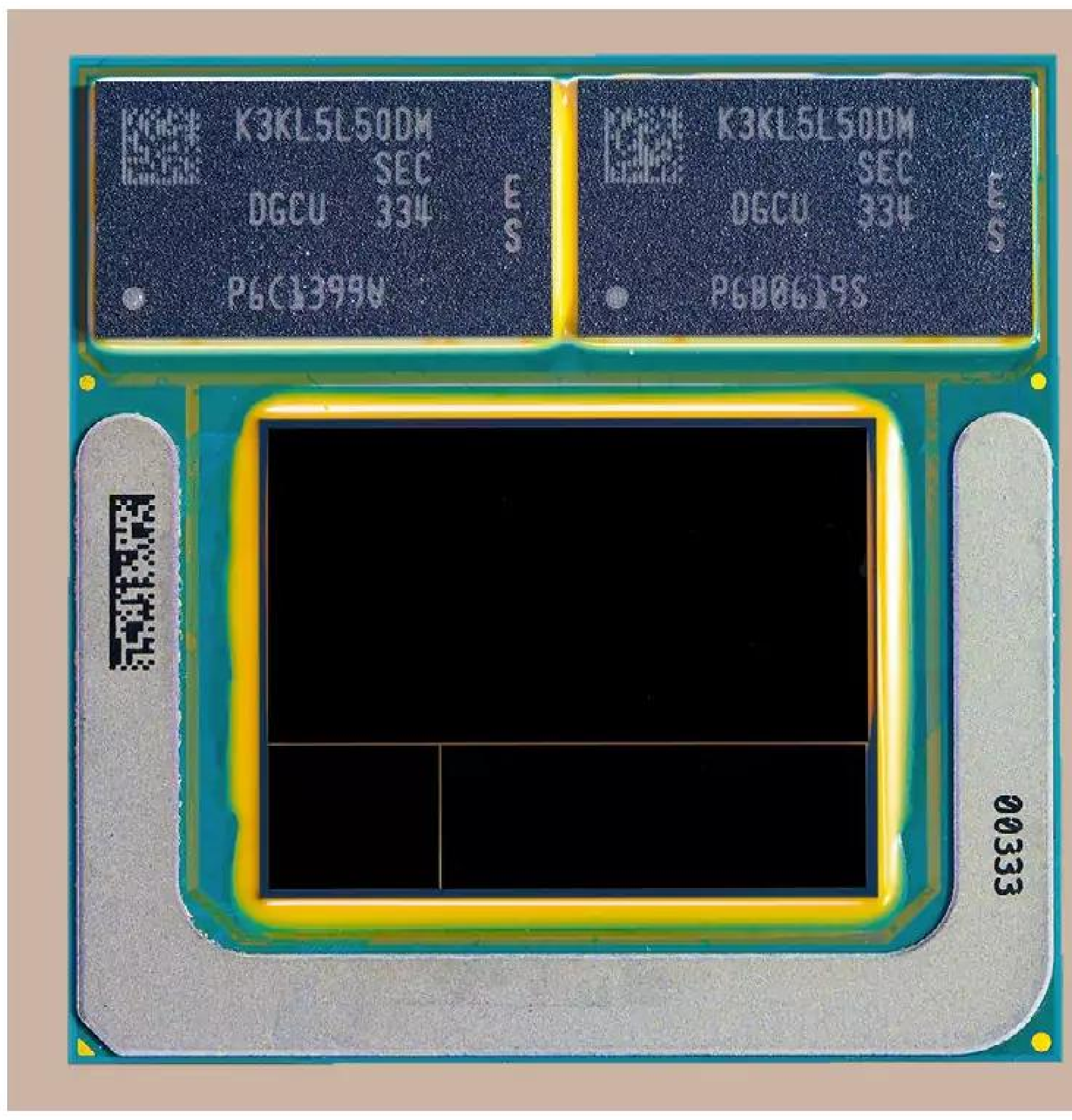
At the moment, eight cores seems to be a sweet spot for x86 CPU performance, but ARM designs are pushing that further. The Snapdragon X Elite has 12 cores, with dual-core boost up to 4.3GHz, and they're all the equivalent of Performance or 'big' cores. Qualcomm doesn't rule out implementing E or 'little' cores in future versions of its processors, which could extend the already excellent battery life of Snapdragon laptops. Apple uses both big and little cores—known as Firestorm and Icestorm in their M1 incarnations—and they're hugely common in portable devices, so it's likely that we'll see them in PCs eventually, too.

NEURAL PROCESSING

The Snapdragon chips are new, and we haven't seen so much as a hint of a second generation. They perform well, so it's possible that they'll settle into a familiar cadence of higher clock speeds, updated manufacturing processes, and occasionally a few extra cores to differentiate new models. What's likely to increase is the capability of the Snapdragon's neural processing unit (NPU), a part of the SoC that's dedicated to running the neural networks behind things like Copilot and Adobe's generative tools for Photoshop.

To qualify as a Copilot+ PC, the NPU in a CPU needs to operate at 40 TOPS or more. TOPS stands for trillions of operations per second, and while this can be hard to quantify, it gives you an idea of the amount of number crunching these chips are capable of. It's a theoretical maximum throughput under ideal conditions, however, so you'll need to be really driving your NPU hard to get the benefit out of an increased TOPS value. AI is something that's likely to push PC specs forward in the next few years, and it's telling that the very first generation of Copilot+ machines are all Snapdragon-powered laptops. Intel and AMD do make NPUs, and Microsoft says it will be bringing Copilot+ to PCs that use them as well, likely in an upcoming Windows update.

Qualcomm's Hexagon NPU, its sixth-generation product, hits 45 TOPS, and you can get an AMD Ryzen AI 300 chip with 55 TOPS. The Apple M4 can manage 38, while an Intel Core Ultra 7 155H offers only 10 TOPS, but upcoming Lunar Lake chips could raise that to 48. This provides a clear upgrade pathway for the future: newer chips equal more TOPS and therefore the potential for faster local neural network processing without needing to rely on the cloud. It's easy to imagine chipmakers marketing their products with the NPU's TOPS count front and center, the specs of the other processing cores in smaller print.



Intel's Lunar Lake chips, which make up the Core Ultra 200V range, are ultra-low power designs with an NPU and integrated graphics tiles.

The rise of the NPU comes from the current AI boom. While the neural networks and language models that make up the cornucopia of AI tools can run on GPUs, and frequently do in data centers, having a specialized local processor makes a lot of sense, as it can speed up results and—in the case of Microsoft Recall or creative work you don't want to leave your computer—improve data security. AI has become such a large and lucrative industry, despite the current lack of a killer app outside of chatbots and image generators, and the ability to sell new PCs by using the promise of exciting new capabilities shouldn't be underestimated. As more Windows features come online, however, we'll get used to using AI to create video subtitles where they don't exist, blurring the backgrounds of video chats more easily and accurately, and quickly filling out sketches with AI-generated detail.

GRAPHICS PROCESSING

Having a powerful graphics processing chip in your PC is one of the best ways to upgrade it, especially if you're interested in playing the latest games. With the launch of Nvidia's GeForce RTX 5000 Blackwell series, we're now four generations into the ray-tracing era of game graphics, and the specs of the 5000 cards reveal an iterative update over the 4000 models, with GDDR7 memory, more CUDA cores, faster clock speeds, and a new generation of DLSS, which is quickly becoming the most useful technology for running games the way we want them to look.

Being able to play games in 4K, at ultra settings, with full ray reconstruction and path-tracing, and at a frame rate of 60fps or above, is the dream of many PC gamers, and the specs of the 5000-series cards could finally be the ones to make this a reality. A new graphics card is the obvious upgrade for your PC, as it's mostly a case of removing the old one and slapping the new one in (as long as your PSU is up to the job, of course -- read our lead

AI is likely to push PC specs forward in the next few years, and it's telling that the very first generation of Copilot+ machines are all Snapdragon-powered laptops

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news story on page 8 to find out more on this).

Nvidia's own product documentation promises a 2x improvement between the 5090 and the 4090 when using DLSS 4 and frame generation, although of course there's also a gen-on-gen price increase as well. We won't know until the silicon is in our test rigs and sweating under the strain of the benchmark suite, but if Nvidia has really pulled this rabbit from the hat and provided an enormous performance boost over the current generation (which is already immensely capable), then top-end PC owners could be in for a very good year. If you're running a 3000-series card or earlier, it could be an obvious upgrade just to get frame generation.

Two interesting things have happened, however, that suggest that a high-powered GPU may no longer be the greatest upgrade you can make. The first is the rise of integrated graphics, driven by the Steam Deck and other handheld PCs. These rely on lower-powered graphics chips, yet are expected to run the latest games, and have been steadily improving, especially from AMD, which already had the Radeon 890M, an RDNA 3.5 GPU integrated into the Strix Point CPUs. It is said to be roughly equivalent to Nvidia's GTX 1070, launched in 2016, but a new challenger has recently appeared in the benchmark charts.

Announced at CES 2025, the Ryzen AI Max+ Pro 395 from the Strix Halo range might not be a chip you'll be able to buy for a gaming machine, more designed for use in enterprise PCs, but it's an absolute monster. It sports 16 Zen 5 cores, which is a pretty good start, but also comes with Radeon 8060S integrated graphics with 40 compute units (for comparison, Strix Point chips have 12) that push its performance into the area currently occupied by the laptop versions of the GeForce RTX 4060 or RX 7600. That's driving into PlayStation 5 territory.

If this is indicative of where AMD is going with its integrated graphics, then the next wave of handheld gaming PCs is going to be interesting. It's not hard to imagine an eight-core version of this chip aimed squarely at games machines, with 16GB of DDR5, a 2TB SSD and a 1080p OLED screen for a sort of super-Switch capable of doing justice to almost anything in your Steam library. Zotac already has a ZONE handheld in the works based on a Ryzen AI 300 Series processor, but we don't yet know if it's a Strix Halo model.

SOFTWARE UPDATE

There's a player in the GPU space that isn't AMD or Nvidia, of course, and that's Intel. The launch of its Arc B580 card at the end of 2024 went well, offering 12GB of VRAM (there might be a 24GB version in the works), XeSS-FG frame generation, a native 16-lane design with DirectX 12 optimizations, and a $250 price tag, and we have great hopes for additional cards further up the hierarchy. The problem with Intel cards has always been the drivers—the first generation received updates that vastly improved its capabilities during its lifetime, and there's no reason to expect that the new cards won't go the same way. Tests show that it's roughly in the RTX 4060 ballpark, but as support from drivers and software improves, we should see better performance and fewer crashes.

Nvidia CEO Jensen Huang unveils a Blackwell graphics processor, which will make its way into the GeForce 5000 cards.

GPU drivers aren't the only software that will see an upgrade in 2025. The programs that make our PCs work never keep still, and are the one thing we can guarantee to change even if we feel we're at a dead end with hardware. Microsoft has been rolling out new versions of Windows every year, and rumors talk of a 'Windows 12' release in 2025, boosted by Windows losing its chief product officer within Microsoft, Panos Panay, to Amazon back in the fall. Any new executives taking over will want to make their mark, and releasing Windows 12 rather than Windows 11 25H1 might just be the opportunity they need. A Windows desktop shown at Microsoft's Ignite conference in 2024 was different enough from the default Windows 11 one to spark speculation that it was Windows 12, but retained enough familiarity to be merely a modded version of 11. Any new OS should make a clean break with the previous version, and advertise its differences and improvements, so Windows 12 putting the Start button back in the left-hand corner by default, or returning to Windows 8's full-screen Start menu, isn't out of the question.

That's speculation, of course, but one thing we can be sure of getting is more AI. Hardware and software are moving in the same direction on this issue, and as NPUs become more capable, and more PCs hit the Copilot+ spec, we will see more tools released. It's hard to say what these will be, as it depends which of the currently available options prove to be the most popular. The rollout of Windows Recall will be an interesting test, showing whether users are prepared to allow an AI to monitor their PC usage and exactly how useful they find its searchable snapshots. In our testing with Recall, it's clear that it's a technology with potential, but its combination of browser history and Big Brother may be too much for some users, as may any bite it takes out of your battery life, and there's a need to balance helpfulness with intrusion. If you're someone who regularly forgets what they were doing, or needs to easily go back to web pages or documents they were working on weeks ago, however, then it's a feature that may get used a lot. It will be interesting to see how hard Microsoft pushes it, and whether Apple makes its own version.

Another thing that's happening to software right now, and can only increase in the future, is the cloud. We've had game streaming from servers over the internet ever since G-Cluster introduced its

It's not hard to imagine an eight-core version of this chip aimed at games machines... a sort of super-Switch, capable of doing justice to your Steam library

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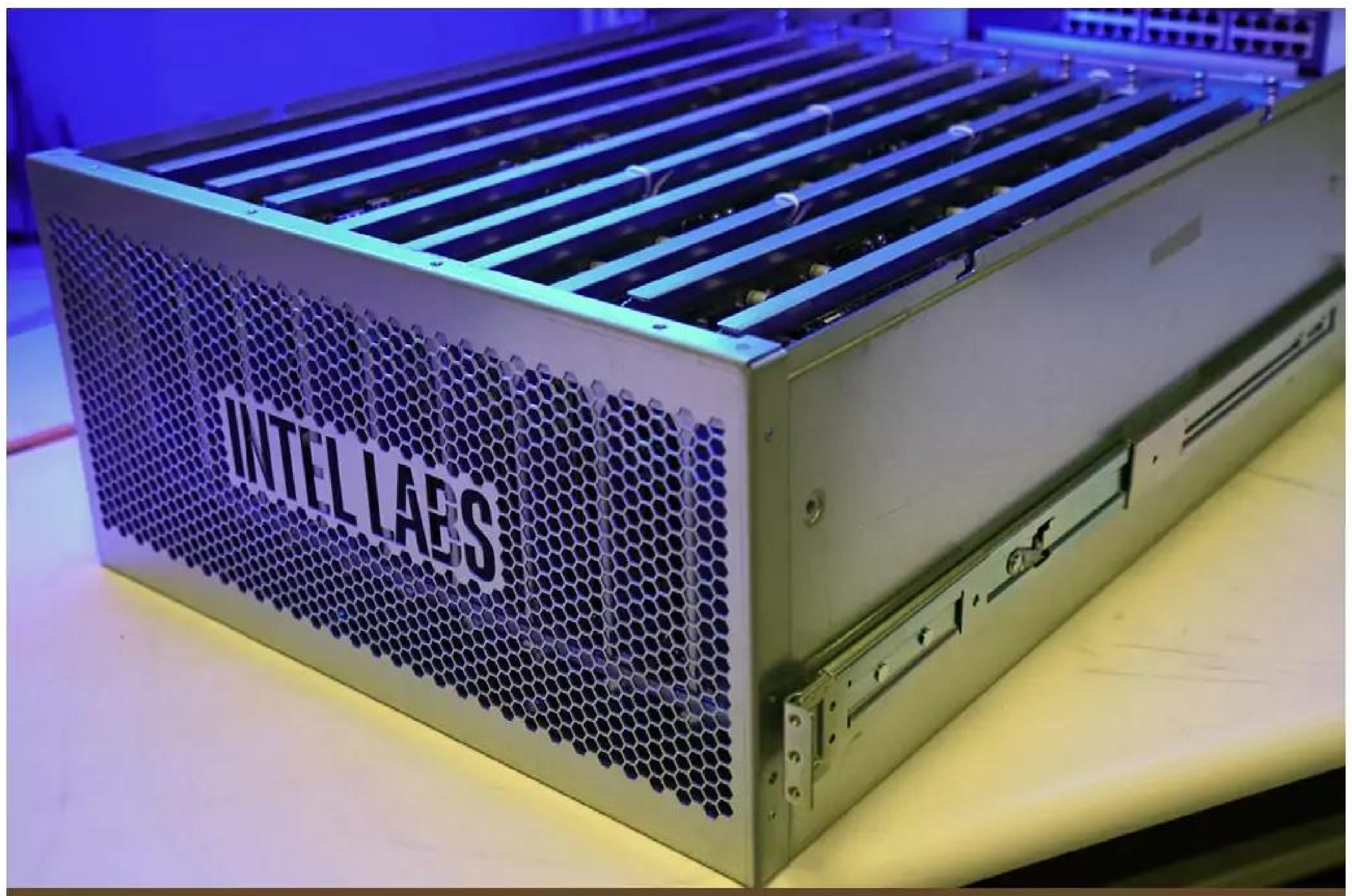

Intel's Pohoiki Springs chips were a rack-mounted data center variant of its neuromorphic computing experiment.

product at E3 in 2000. Since then, as internet connection speed has increased and latency reduced, more services have sprung up, including OnLive and Gaikai, the latter of which was bought by Sony and used as the foundation of its PlayStation streaming service. In 2025, we have streaming from Nvidia, Amazon, Microsoft, and more, with the technology starting to spread beyond just games. Microsoft's taking this a step further with Windows 365, a streamed Windows desktop that makes anything a PC, as long as you keep paying your subscription.

This kind of pricing has a history in the streaming world. We happily hand over handfuls of crisp dollar bills each month for Game Pass, Microsoft Office, Google Drive, or Adobe Creative Cloud, but Windows has always been something we pay once for, and which feels like we don't pay for at all, as a license is almost always included with a new PC, and can be easily transferred through our Microsoft accounts. Cloud PCs are really a thing company IT departments want, making it easier to control hardware security and roll out patches and new software without needing to have physical access to the machines you're upgrading. They can stop employees from running apps they shouldn't, plugging in USB drives to copy company information onto, and even accessing websites you don't want them to. All of this can be achieved through current versions of Windows 11, but centralizing them in a server complex somewhere makes it a lot easier.

We're not sure that a cloud PC makes complete sense for home users, as it requires fast networking that you might not have if you live outside a major city (and even if you do), but it does democratize access. PC gaming, or indeed, anything that requires a powerful machine, is expensive, and more people are likely to be able to afford $31 a month (the current basic subscription rate for Windows 365, and more than the $20 cost of GeForce Now Ultimate) than they are a $2,000 PC. Being able to use a Windows desktop from a cheap Android tablet increases the accessibility of PCs, and that can only be a good thing. Windows may become the operating system equivalent of a live service game like *Helldivers 2*, with patches being applied every time you start it up in response to user feedback, and with problems fixed just as quickly. We're only going to see more of this, though we hope a local installation remains an option.

MEMORY MANAGEMENT

The RAM sticks inside our PCs are in a state of constant improvement. Even when a new flavor of DDR hasn't been released in a year, you can guarantee that some high-end chips that run at higher speeds will have appeared, forcing power users into a dilemma over transfer speeds versus CAS latency. DDR5 has shown itself to be a robust system, hitting speeds of 8,200MT/s under Intel XMP 3.0, or possibly, by the time you read this, even higher. Anyone sitting with 3,000MT/s DDR4 in their gaming PC will get the itch for an upgrade just from reading that.

Nothing stays still, though, and DDR6 is around the corner. Its standard top speed should be 12,800MT/s if the JEDEC standard is to be believed, with overclocking able to increase this, and we should be looking at four 24-bit memory channels per module, a doubling of DDR5's two 40-bit channels. This, plus the higher speeds, gives a significant increase in memory bandwidth. The voltage the RAM needs to run will also change—DDR4 used 1.2V, DDR5 1.1V, so a lower figure is easy to predict for DDR6, which translates as better battery life for laptops and portables. We should also see increased capacity—potentially 2TB of memory per module—but that's a long way off being significant in the home PC market, where 64GB is considered more than enough.

One thing we do know is that AI is thirsty for RAM—there is a requirement for 16GB of DDR5 for a machine to be considered a Copilot+ PC, and more is always better—so the chances of 32GB of RAM becoming the standard amount in 2025 are pretty high. Games will love this, too, especially as faster RAM with higher bandwidth will make it easier to shuffle data out to the graphics card. GPUs with 8GB of RAM onboard are already struggling with textures in 1440p games, and the first release of RTX 3080 cards, with their 10GB memory pool, will be the next giants to fall. As 4K gaming becomes more prevalent, we can expect 16GB or more on our graphics cards, with the GDDR7 spec—which offers 40 percent higher bandwidth than GDDR6—looking good for the time being. GDDR8 is a certainty, but we haven't seen any sign of it yet.

Let's not forget the role of non-volatile storage in all this. We're still getting to grips with PCIe 5.0 SSDs, which are great for large file transfers, but offer minimal gains over cheaper 4.0 drives in everyday use, but the 6.0 spec is already written. As expected, it doubles the numbers that matter, with a 64 GT/s raw data rate and up to 256GB/s in its x16 configuration. This means that SSDs, which usually connect via a 4x slot, will operate at 32GB/s. That's very fast, and will mean more for external drives connected via Thunderbolt or USB 4 than it will for internal drives, as external storage tends to be used for larger files, written once, rather than constant reads and writes. This is one area where we might have reached a workable maximum for the time being, as for games and other programs, the SSD has already done enough to bring down loading times, and internet connection speeds haven't advanced to the point at which downloading a game from Steam is going to be bottlenecked by your SSD, and even the best speeds from Wi-Fi 7 can't match PCIe yet.

> **We're still getting to grips with PCIe 5.0 SSDs, which are great for large file transfers, though offer minimal gains over cheaper 4.0 drives in everyday use**

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Data centers like this are where a lot of our AI and cloud data is processed, and more are built all the time.

THE FAR FUTURE

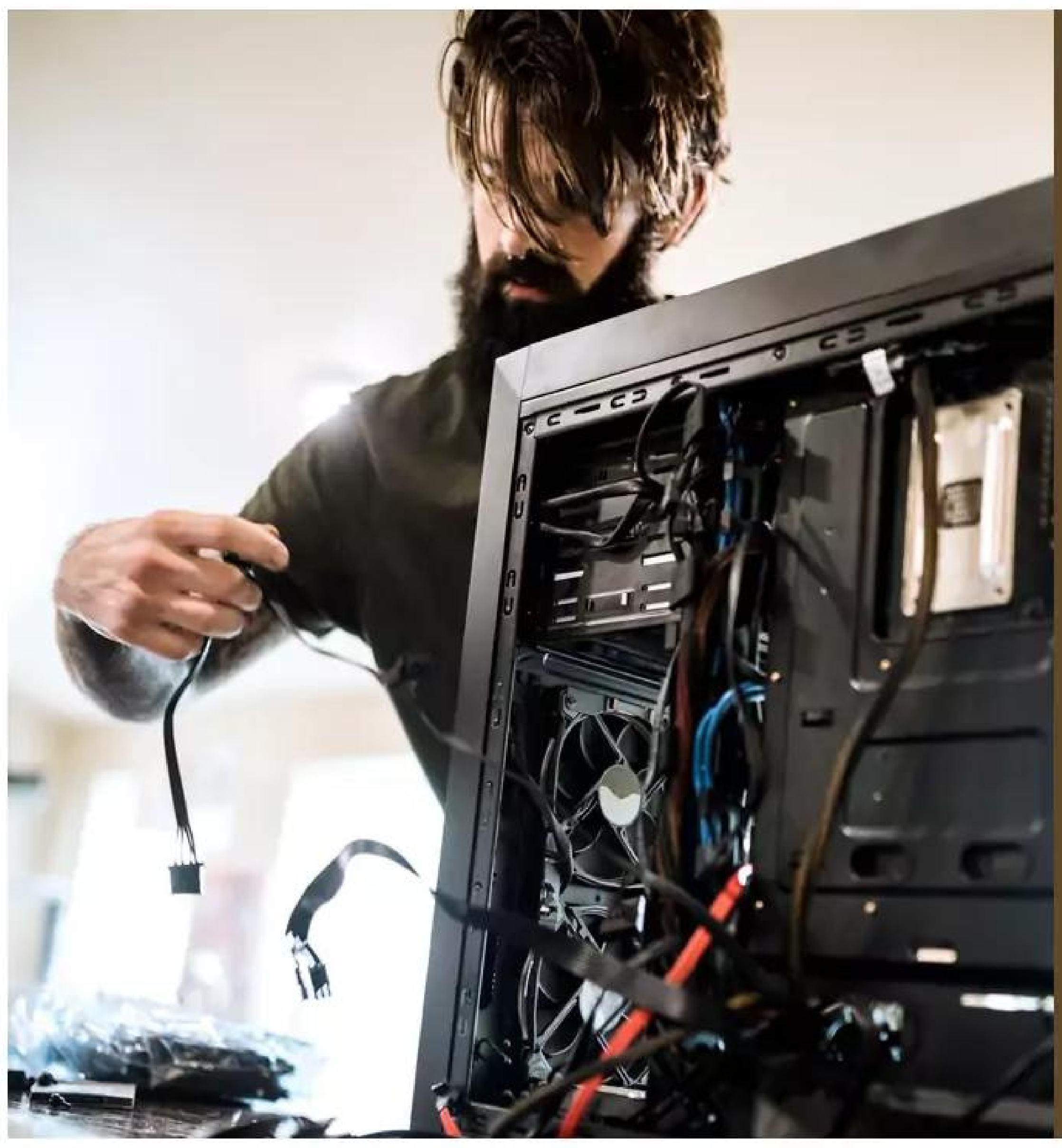
Every now and then, a group of scientists gets excited about a discovery, and puts out a press release detailing how it's going to revolutionize computing. Then nothing happens, only for the same idea to reappear several years later. Quantum computing has been 20 years away from the mainstream ever since its discovery, and Intel's Pohoiki Beach, the codename of a system it dubbed 'neuromorphic computing', and which claimed to run algorithms in a similar way to the human brain, much like today's NPUs, was announced in 2019.

There are some interesting ideas on the horizon, however, one of which involves light. Research published in *Nature* at the end of 2024 from researchers at MIT, Berkeley University, and Colorado University Boulder describes a chip that uses light instead of electrical signals to transfer data. MIT has immediately pegged this to deep-learning networks and the AI boom, but it doesn't take much imagination to see this technology becoming mainstream, as it plays into the industry's current obsessions with doing more calculations with less power. With the energy and water use of the data centers that currently house our attempts at AI, that can only be a good thing.

There's more going on as well. Chinese chip manufacturer Loongson wants to compete with AMD and Intel with its processors, and the 3C6000 CPU offers 16 cores and a DDR4-3200 memory bus. It's said to match the performance of the Intel Xeon 4314, a chip from 2021. Another company, Ubtium from Germany, is making a RISC-V chip designed to be universal, combining the functions of CPU, GPU, DSP and FPGA in one chip. RISC-V, an open-source instruction set that came out of the University of California, Berkeley, is scalable and modular, and could become as big a player as x86 and ARM if the software support is there.

One thing hasn't changed: the best time to upgrade your PC is always right now, especially if your current components are a few years old. This isn't feasible, for financial and other reasons, for a lot of people, however, and it's easy to get into a loop of constantly waiting for a new generation of cores or cards to be released before you take the plunge.

The central question we're asking here, 'Have we reached maximum PC?' gets a straightforward 'no' as its answer, but there's no denying that we've reached a plateau on which every improvement feels evolutionary rather than revolutionary. The current PC ecosystem is a very large one, in which hardware and software from multiple vendors has to work in sync in order to effect changes, and making any kind of change can take a long time. What we suspect is more likely to happen is that a series of minor alterations and updates pile on top of one another to create what appears to be a big jump if viewed from a long enough distance, but seem inconsequential when you're in the midst of it. We may never see the launch of a new type of processor again, but we'll keep upgrading all the same.



One thing hasn't changed: the best time to upgrade your PC is always right now, especially if your current components are a few years old.

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THE EVOLUTION OF VIDEO GAME AI

Over time, game AI has become more refined.

ANYONE'S WHO ever played *Space Invaders* or one of its many clones remembers how the aliens relentlessly bear down on the player until they're either destroyed or collide with your ship. This is one of the earliest examples of game AI (Artificial Intelligence), where developers made clever use of scripted responses to enemy NPCs capable of challenging players.

These days, AI can be used to do much more than have the *Pac-Man* ghosts run around a maze. Innovations like procedural content generation can spontaneously generate in-game items and even entire worlds. LLMs can even be used to inform enemy and other NPC behaviors, creating more realistic interactions.

Still, the course of in-game AI hasn't always run smoothly. Here, we'll chart its progress, from chess programs that were laughably easy to defeat, to how bleeding edge AI is used in modern games to enhance play and graphics. **–NATE DRAKE**

From lead to gold

IN OCTOBER 1960, philosophy professor Hubert Dreyfus published a RAND Corporation memo entitled 'Alchemy and Artificial Intelligence'.

In the paper, which formed the basis of his later book, *What Computers Can't Do*, Dreyfus launched a scathing attack on over-optimistic predictions about the field of AI, comparing it to the mythical process of alchemy.

He took particular issue with the claim by AI pioneer Herbert A Simon in 1957 that in ten years' time, a digital computer would be the world's chess champion. Dreyfus recognized the ability of Simon's GPS (General Problem Solver) programs to solve relatively simple tasks like the 'Cannibals and Missionaries' logic problem. However, he pointed out that the NSS chess program, which Simon had co-created in the late 1950s, had been beaten by a ten-year-old novice.

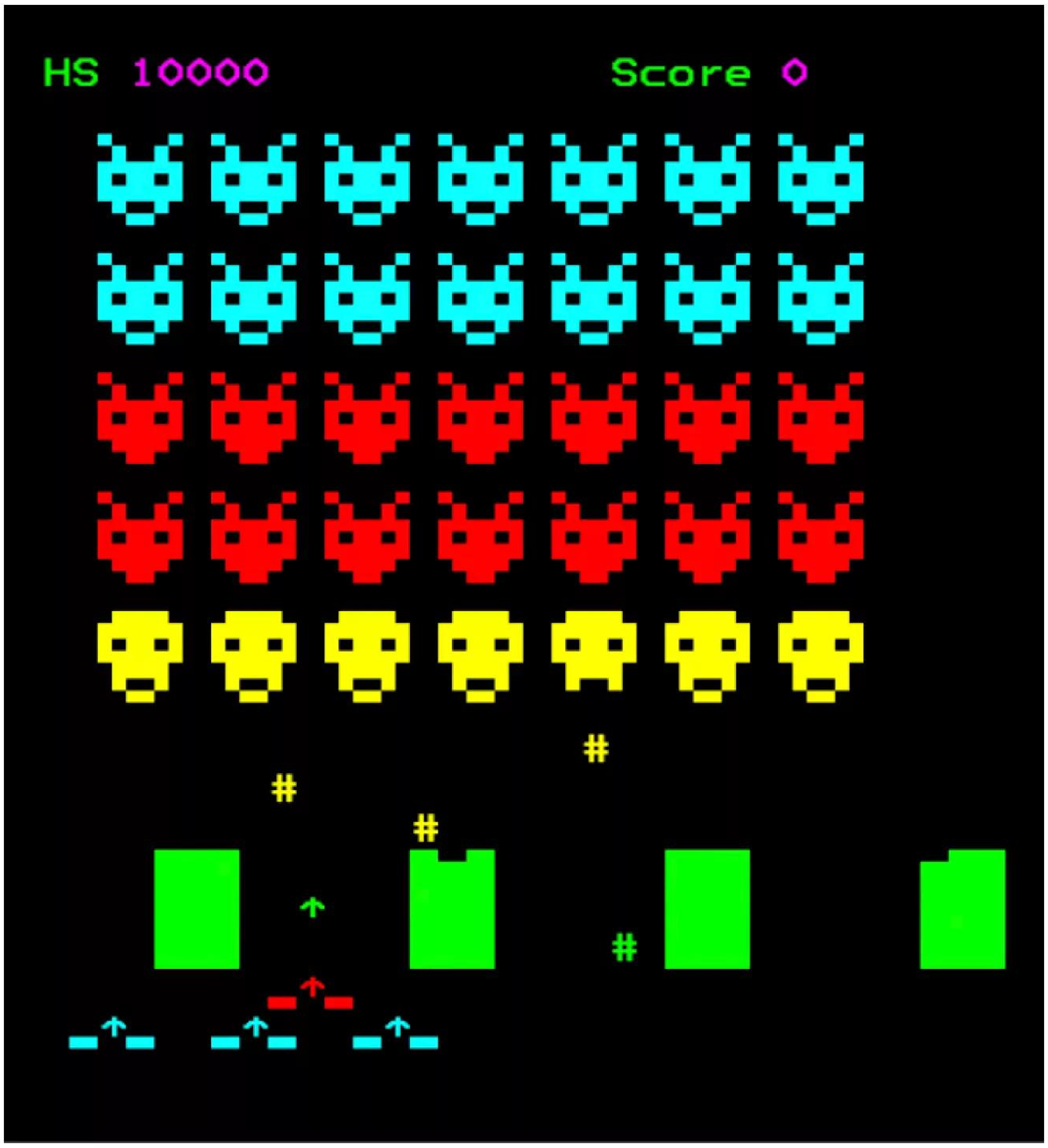
Drefyfus did go on to acknowledge gains in the field of AI. Still, his philosophical stance was that machines can't be intelligent in the same way as a human. In essence, he argued about the distinction between "knowing that" and "knowing how". Computers did and do excel at "knowing that" complex problems can often be solved by methodically trying every solution until finding one that works. The "knowing how" is a more human way of reasoning in context, such as standing on the strongest branch when climbing a tree. This reflects people's ability to intuit the best course of action without considering every alternative.

When it came to chess, this gave man an edge over machines, given that there are up to 10^123 legal and illegal moves. As early computers could only evaluate a few thousands moves per second, this meant that a computer opponent could take up to eight minutes to respond.

This wasn't lost on MIT undergraduate Richard Greenblatt, who had read a similar paper to Dreyfus's outlining the shortcomings of AI. Despite the misgivings of his thesis adviser, Greenblatt resolved to develop a program capable of playing tournament-level chess.

The program, later dubbed 'MacHack' was developed in stages on a PDP-6. Realizing the enormous number of potential moves, Greenblatt applied 50 heuristic rules. These built on his own knowledge of chess, and the fact that 25% percent of all move sequences transpose to the same end position.

In 1967, a team of MIT researchers and students challenged Dreyfus to play a game against Mac Hack. After a long game, the computer ultimately checkmated the professor in the middle of the board.



Enemy AI in *Space Invaders* is limited, as the aliens don't respond to player actions.

By the time the program was published officially in 1969, it had already competed in 18 tournaments. The PDP-6 on which it was compiled was even made an honorary member of the Massachusetts State Chess Association and the United States Chess Federation.

While the AI community may have felt vindicated, these types of programs were costly to develop, and could only run on extremely expensive hardware. This meant that some of the earliest video games released outside academia, like *Tennis for Two* and *Spacewar!*, were designed for two players, freeing up game resources to focus on graphics. This trend continued into the first arcade games released in the early '70s, as *Pong* and *Computer Space* were based on the aforementioned early videogames and relied on two human players.

Admittedly, the ball in *Pong* was programmed to move in response to how players moved virtual paddles. This rudimentary form of AI was also found in Taito's *Space Invaders* in 1978.

The aliens initially appear in rows at the top of the screen. They are deterministic in that they move from side to side and inexorably downward towards the player. While the game was one of the first arcade titles to introduce enemy NPCs, they cannot be described as intelligent. Even the UFO that moves across the screen is determined by calculating a random value, regardless of the player's actions.

The popularity of *Space Invaders* can be explained by other aspects of play, such as 'endless' play, in that the levels restart indefinitely. The original game control board also was able to render fewer aliens more quickly, resulting in faster movement the more aliens are killed. Developer Tomohiro Nishikado decided not to leave this bug in, as it made for more exciting play.

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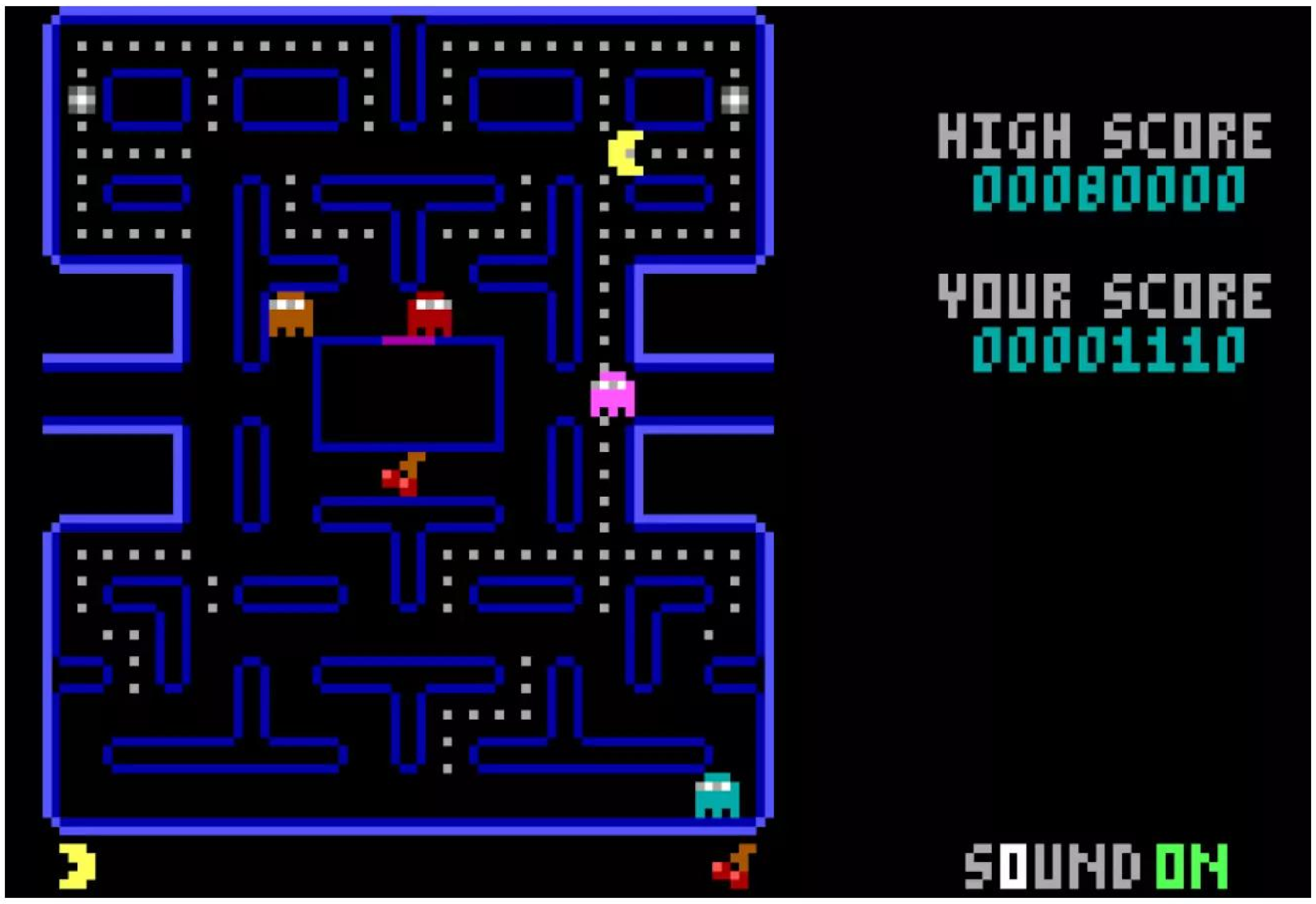
Strategies and states



***Pac-Man*'s enemy ghosts each have a distinctive AI 'personality' determining their behavior.**

AMMO
HEALTH
ARMS
ARMOR

Enemies in *Doom*-based titles won't attack until they see or hear the player.

THE PREDICTABLE PATTERNS used by the alien NPCs in *Space Invaders* established a precedent that has since been held in videogames: it truly doesn't matter how objectively clever a game's AI is, provided the player perceives it that way.

In the '70s and '80s, when hardware processing power was relatively limited, programmers often struggled to create convincing AI for players. Still, Namco's *Pac-Man* (1980) was a quantum leap for both enjoyable gameplay and sophisticated enemy AI.

As *Maximum PC* readers know, creator Toru Iwatani programmed the game so that the eponymous hero moves around an enclosed maze, trying to gobble up colored dots. Pac-Man is hindered in this by four ghosts, who will chase him down. If Pac-Man comes into contact with a ghost, he loses a life, and the level restarts.

Even in the early Eighties, programming a 'maze chase' game wasn't too difficult. Iwatani could easily have just had the ghosts move around randomly, colliding off walls or even program them all to converge on the player. However, part of *Pac-Man*'s charm is that each of the ghosts are individually programmed with their own 'personality'.

For example, Blinky's (red) personality is described as 'shadow' in the game documentation. True to form, he will give direct chase to Pac-Man by being programmed to head to whatever game 'tile' the hero currently occupies by the shortest route possible.

The pink ghost (imaginatively named 'Pinky') has a 'speedy' personality. She operates by examining the game grid and calculating a position four tiles ahead of Pac-Man, which then becomes her 'target tile'. This doesn't necessarily have to be somewhere the ghost can actually reach; it just informs Pinky's movement, often resulting in her cutting off unwary players. Of course, in a situation where Pac-Man is being pursued by Pinky, the player can always briefly reverse direction to change the ghost's target tile.

The cyan ghost Inky is configured with a 'bashful' personality. The ghost waits to pursue Pac-Man until the player has consumed at least 30 dots. It then calculates its target tile as a vector based on both Pac-Man and Blinky's position. If the player isn't near Blinky, this can result in highly unusual movement patterns.

The orange ghost, Clyde, is described as 'pokey', given that he appears to be unconcerned with Pac-Man's movements. However, this is a feint. In fact, Clyde switches between two states. If the ghost is within eight tiles of Pac-Man, it will chase him in the same way as Blinky. If not, Clyde will move to his 'scatter' tile at the bottom-left corner of the maze.

As any *Pac-Man* player knows, the overall effect of these simple AI rules requires constantly adapting to the movements of all four ghosts, resulting in a highly challenging and interesting game.

Given that this isn't a treatise on *Pac-Man* alone, we haven't touched on the different 'modes' ghosts can enter, such as 'scatter', when they move to a predetermined position on the screen, or 'frightened', when Pac-Man is chasing them after eating a power-up pill.

Still, even the AI for simple games needs to record the state of the player, enemies, and objects. In *Pac-Man*, this can be done through simple algorithms—the ghosts are either in 'chase', 'scatter', 'frightened', or 'dead' mode.

However, this is difficult to scale for more complex titles. This is where FSMs (Finite State Machines) are useful. These are a good way to categorize behavior of game elements like enemy NPCs, as well as the conditions by which you can change from one to another.

One of the best examples of FSMs being applied to games is the *Doom* (1993) engine. All state definitions in the game are stored as a global array. This defines information like which sprites to play for the 'actor' in question, its dimensions, health, and so on. For instance, in *Doom*, each time you start a level, enemies are typically placed at certain locations in the 'spawn' state. This means they are fixed to a particular tile, though typically two sprites are defined to make the enemy look like they're walking in place.

If the player makes a sound by firing a weapon or moves in the enemy's line of sight, they will enter the 'see' state and begin hunting the player by moving toward them by the shortest path. If the enemy gets close enough, it can enter a 'melee' state to physically attack them. Enemy NPCs with ranged weapons can also enter a 'missile' state to open fire on them.

If the player fights back, this triggers the P_DamageMobj function, which determines the enemy's state. For example, if the player fires back and injures the enemy, the *Doom* engine calculates a random value based on the enemy's predetermined 'pain chance' to determine if the 'pain state' is activated, so it reacts to being injured.

Attacking an enemy also means that its current target is set to the player, so if it wasn't doing so before, it will use its specific attacks against them.

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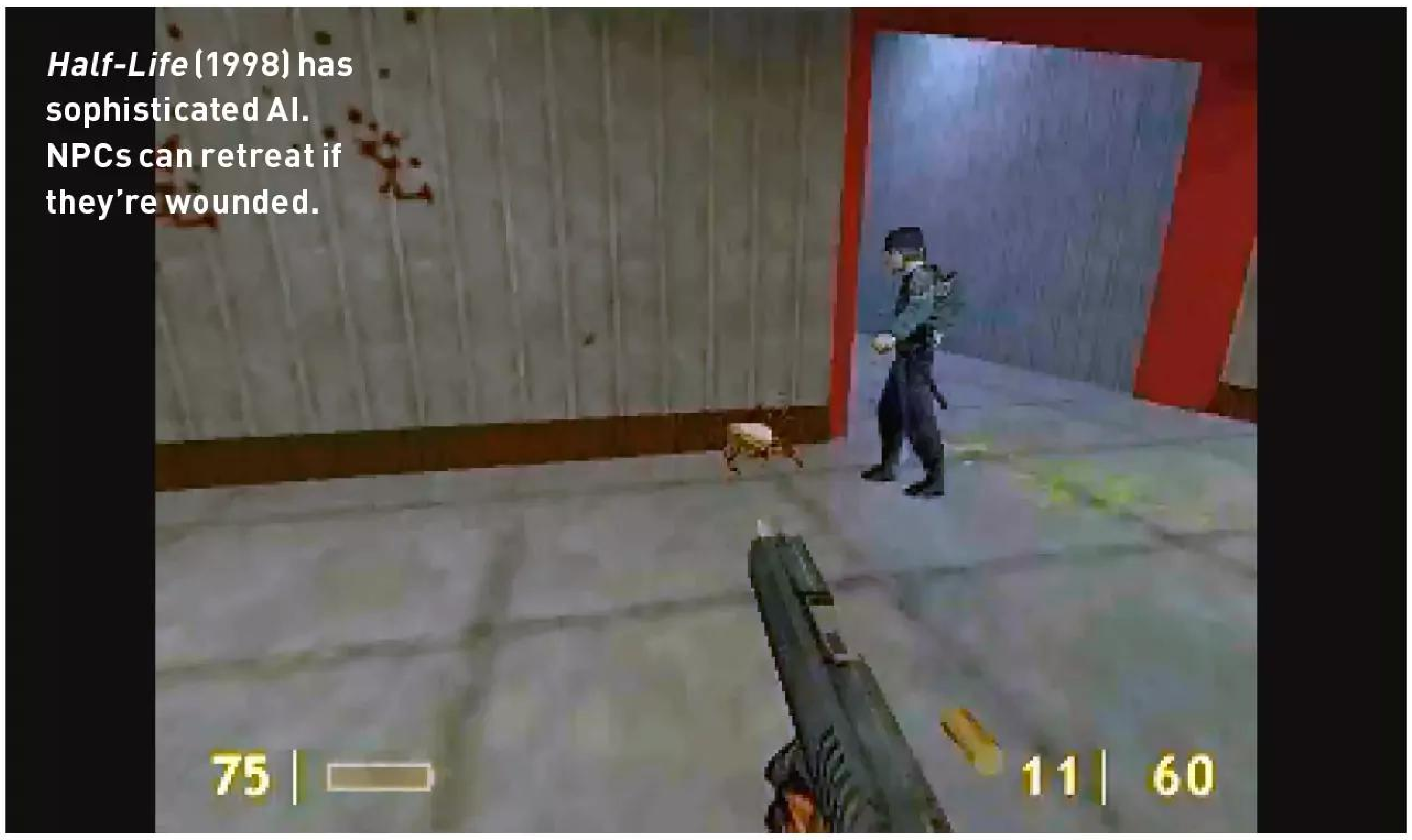
Branching out

WHILE PROCEDURAL generation and language models were years away, the '90s did see some improvements in classical game AI. Valve's *Half-Life*, for instance, used a more sophisticated FSM than earlier titles. As with *Doom*, enemies still patrolled sectors of the map and attacked if they detected the player. However, they could also retreat if the player approached too close or they were taking too much damage.

This was one of the first instances of 'hierarchical' finite state machines. This essentially allowed for multiple FSMs within FSMs. For example, you could have one state machine managing an enemy's behavior at rest, such as patrolling an area. If the enemy detects the player, it can move to another FSM that manages attacking behaviors. Should it get too damaged, an FSM can be enabled to manage its actions when retreating. This approach is still used in games, including the 2016 remake of *Doom*.

Half-Life also pioneered 'goals'. These are overriding AI directives that NPCs will try to accomplish unless programmed otherwise. The game has five, such as GOAL_ATTACK_ENEMY, which causes an enemy to fight the player unless a state is triggered, causing it to retreat or die.


Half-Life **(1998) has sophisticated AI. NPCs can retreat if they're wounded.**

The concept of an NPC that follows instructions according to a game's internal logic was developed further with 'behavior trees'. One of the earliest examples was coded into *Halo 2* (2004).

Behavior trees are made up of 'nodes' and 'branches'. Nodes have elements of game logic, and branches define what nodes to examine. Sequence nodes determine the order in which child nodes are executed. Conditional nodes execute sub-trees under in-game conditions. Behavior trees also have 'leaves' with no child nodes. Behaviors are defined here.

In *Halo 2*, the 'Brute' enemy will usually attack the player under all circumstances. However, the 'Grunt' enemy tends to run away from battle if its leader is killed. Behavior trees make it simpler to code AI behavior, as parent nodes can determine generalized behavior, while child nodes can be specific to each type of NPC.

However, there are times when enemy actions as determined by the game's built-in 'priority' list aren't appropriate. This is where the AI can activate an 'impulse trigger' to prompt the enemy down a different branch of its behavior tree. For instance, if the player takes cover inside a vehicle, the enemy will also try to enter.

GAMING THE AI

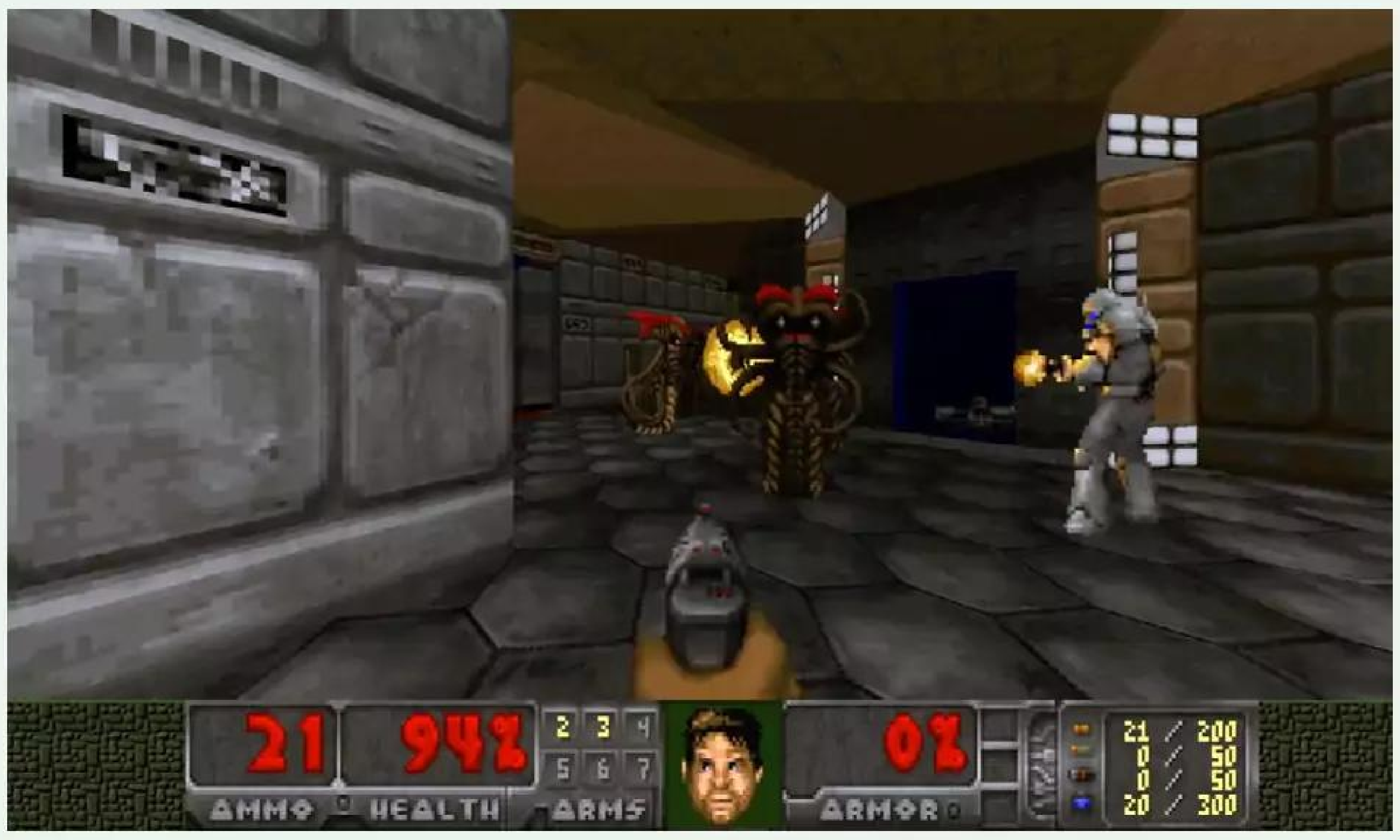
While *Doom*'s FSM resulted in the appearance of a sophisticated enemy AI, anyone who has played the game at lengths knows it has its limits. For instance, sounds from weapons can spread across sections, waking enemies up from the 'spawn' state and causing them to rush the player. For this reason, most level editors support a 'Deaf' flag to prevent enemies in different sections from activating before a player is ready.

There's also no hard-coded limit on most enemies' line of sight, meaning flying enemies like the Cacodemon can detect and approach long before they're visible to players.

Typically, enemies react to being attacked by setting whatever injures them as the current target. Skilled players can use this to game the enemy AI and trigger 'Monster infighting'.

In essence, this involves tricking one enemy to attack another through unintentional friendly fire. If one monster blocks another's line of sight, the AI requires enemies to keep attacking. The monster may shift their target from the player to the other enemy that injured it, then attack them. Triggering monster infighting is easiest with enemies who perform missile attacks.

One classic example is *Doom II*'s MAP20: Gotcha level, which contains two of the most powerful enemies in the game: a Spider Demon and a Cyberdemon. It's easy to get one hit to accidentally hit the other, triggering a bloody battle between the two.



The AI in *Doom* can by tricked to make enemies attack each other.

All titles that use the *Doom* engine, like *Hexen*, can be gamed like this. However, when id released *Quake* (1996), the AI was updated so enemies of the same kind won't fight each other.

Players have continued to exploit infighting in other titles. For example, many of the hostile AI 'mobs' in *Minecraft* can be tricked into fighting if the player can get one to damage the other.

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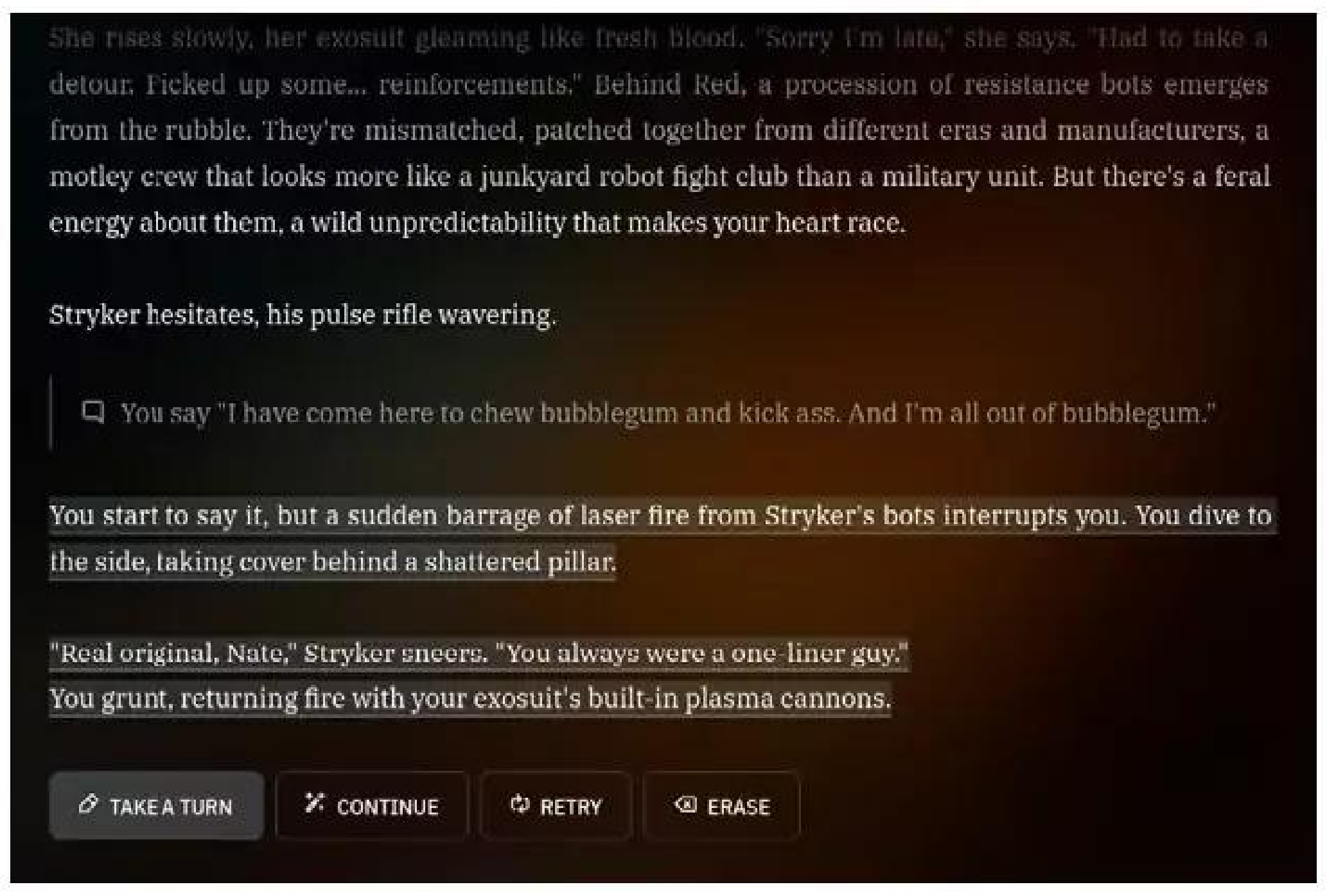
Driving directions

Left 4 Dead's AI director changed game conditions depending on team performance.



She rises slowly, her exosuit gleaming like fresh blood. "Sorry I'm late," she says. "Had to take a detour. Picked up some... reinforcements." Behind Red, a procession of resistance bots emerges from the rubble. They're mismatched, patched together from different eras and manufacturers, a motley crew that looks more like a junkyard robot fight club than a military unit. But there's a feral energy about them, a wild unpredictability that makes your heart race.

Stryker hesitates, his pulse rifle wavering.

You say "I have come here to chew bubblegum and kick ass. And I'm all out of bubblegum."

You start to say it, but a sudden barrage of laser fire from Stryker's bots interrupts you. You dive to the side, taking cover behind a shattered pillar.

"Real original, Nate," Stryker sneers. "You always were a one-liner guy."
You grunt, returning fire with your exosuit's built-in plasma cannons.

Text-based AI games can create new content, as determined by the player's actions.

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WHILE HIERARCHICAL FSMs and behavior trees generate more realistic behavior from NPCs like enemies, it doesn't necessarily make for better gameplay or good replay value.

Valve's *Left 4 Dead* (2008) addresses this by introducing 'Director-based AI'. In the game, the AID (AI Director) eschews traditional spawn points for enemies. Instead, it determines the location and numbers of 'the Infected' based on a number of factors, like the current player's skill level.

When a map loads, the AID can also place certain items at predetermined spawn points. These vary depending on the player team's performance. For instance, if team members are injured, the Director can place health kits.

The game's 2009 sequel gave the AID much greater powers through dynamic map design, again based on team performance. One example is found in the 'Cemetery' stage of the final 'Parish' campaign. If a player's team is doing too well, they will find more gravestones blocking their route.

The *Forza* racing game franchise also represented a great leap forward for in-game AI. When *Forza Motorsport* first hit the shelves in 2005, few players knew that the 'drivatar' AI for other in-game cars was built on studies by Microsoft's Research Lab in Cambridge, UK.

The first *Forza Motorsport* used a Bayesian Neural Network to record racing lines and characteristics of how the player drove their car. It would then use this data from previous races to calculate the feasibility of solutions to problems. For instance, if a 'drivatar' car is approaching a corner, said data can be used to determine the optimal angle and acceleration to turn successfully.

Initially, this data was saved to the Xbox's internal 8GB Memory Unit. The saved data was then used to train the drivatar AI each time the player raced. However, as of *Forza Motorsport 5* (2013), the series makes use of the Xbox One cloud and a reinforcement learning (RL) paradigm to record data for all players connected to the cloud. This allows new behavior models to be calculated for Drivatar behavior. Players can even download new AI cars with updated behavior. All player driving data is recorded and timestamped. The drivatar AI favors newer data for training, on the basis that player performance on tracks will improve over time.

PROCEDURAL CONTENT GENERATION

The *Forza* franchise is an excellent example of how deep learning using ANNs (Artificial Neural Networks) can be used to adapt to player behavior, providing better replay value and a more enjoyable gameplay experience.

In the case of the AI racing cars in *Forza Motorsport*, the process used is a form of 'reinforcement' learning by analyzing past player driving performance and trying out strategies to navigate obstacles like corners to find an optimal approach.

Another exciting aspect of machine learning in videogames relies on using PCG (procedural content generation). One of the earliest examples of this was *Rogue* (1980). The game's algorithm worked by generating a dungeon room into which the player would spawn. It would iterate at random through more rooms, determining if each was accessible by its neighbor, then placing stairs in the last room, so players could proceed to the next level.

Although the scope and type of generated content are greater, *Minecraft*'s world generation operates in a similar way. The game AI begins with a 'noise map' generated using random numbers from a quadratic congruential generator. This represents basic land to ocean at a ratio of 1:10.

The 'biome' map, such as deserts or mountains, is selected. A basic outline for the map determines the height for each region with surface stone blocks. Surface stone blocks are placed on these, appropriate to the biome. Finally, elements like ravines, trees, and villages are added.

The PCG in both *Rogue* and *Minecraft* are excellent examples of 'random assembly', in that manually created elements, such as dungeon rooms or grass blocks, are assembled together via an algorithm.

No Man's Sky (2013) expanded this concept further by generating entire universes via machine learning. Almost all planets, creatures, ships, multi-tools, and other items are created via procedural content generation.

While developer Hello Games hasn't detailed how this works, founder Sean Murray has said that the player's position is used to inform the LSS (Local System Seed) used

Robo moderators and upscaling

ACCORDING TO a recent report from Unity, toxic behavior in gaming increased from 68 percent in 2021 to 74 percent in 2023.

Around one third of this is accounted for by cheating. Kernel-level anti-cheat systems like Vanguard protect titles developed by Riot Games, like *Valorant* (2020). This is problematic, as it requires high-level access to players' systems, sometimes when the game isn't running.

Cheaters are also becoming more innovative at bypassing kernel-level cheats, such as by using custom hardware. This is why anti-cheat systems combine kernel-level software with server-side monitoring and machine learning.

For instance, *Fortnite* cheaters often install unauthorized 'aimbot' software to calculate the trajectory of a player's shots, then aim their gun at a target. Epic Games' EAC (Easy Anti-Cheat) deploys AI to examine player behavior. This data can be gathered against statistics gleaned from other players to determine average statistics for aim time and precise shots.

Naturally, AI is also used to combat other forms of bad behavior, like harassment. This hasn't always been received well. For instance, the AI moderation tools in *Elder Scrolls Online* reportedly monitor all in-game conversations, so players could get banned for private conversations or light-hearted taunting between friends if certain keywords are detected.

The use of artificial intelligence to improve videogame graphics has been much better received. One of the most significant advances in this field is Nvidia's Deep Learning Super Sampling (DLSS) technology. It uses AI to enhance game assets like textures, shadows, and environmental details in real-time.

This is achieved through multiple techniques. For instance, GeForce RTX GPUs can use AI to ouput higher-resolution frames from a lower-resolution input. DLSS achieves this by sampling multiple low-res images, then uses motion data and feedback from previous frames to reconstruct high-quality images.

For instance, the latest version of *Cyberpunk 2077* supports DLSS 3.5, which includes 'ray reconstruction'. This uses AI to generate additional pixels for intensive ray-traced scenes, which is more efficient than hand-tuned denoisers.

AMD also plans to deploy version 4 of its FidelityFX Super Resolution (FSR) technology in titles like *Call of Duty: Black Ops 6*. Like DLSS, FSR 4 will use AI-based techniques for upscaling graphics. The company also plans to use frame generation and interpolation to improve game battery life on handheld devices.

Moderation and anti-cheat systems sometimes raise false positives. Titles that use procedurally generated content to create worlds can look uninspiring compared to manually designed in-game assets. Relying on AI to generate graphics and dialogues for NPCs can be problematic if they reinforce harmful stereotypes or don't move the game forward. Still, there's no denying that players can become frustrated with NPCs' repetitive actions and speech.

A recent report into the future of NPCs found that 99 percent of gamers feel that AI will enhance gameplay. As the technology is further integrated into popular titles, time will tell.

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Easy Anti-Cheat is the industry-leading anti-cheat service, countering hacking and cheating in multiplayer PC games through the use of hybrid anti-cheat mechanisms.

Anti-cheat systems can detect anomalous behavior like extremely high firing accuracy.

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to calculate content like planets and terrain.

However, PCG has limits when it comes to world building. When *Cyberpunk 2077* was released in 2020, CD Projekt Red's lead cinematic animator, Maciej Pietras, emphasized that the game's 'Night City' would be an open world, but created manually. He said that this was due to the difficulty of procedurally generating realistic virtual content like tall buildings, as compared to open terrains like those used in *The Witcher 3*.

In the same year, Nick Walton of Brigham Young University's deep learning lab released *AI Dungeon*. The initial release used an early version of the GPT-2 natural-language-generating neural network created by OpenAI.

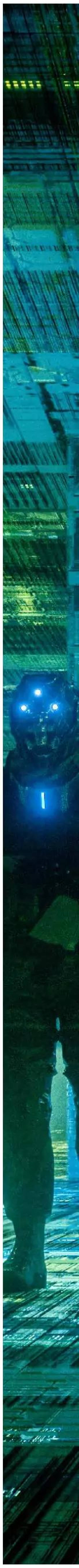
It was inspired by tabletop games like *Dungeons & Dragons*, where players can take actions within parameters defined by a dungeon master. The AI generated a finite list of functions. However, later versions of *AI Dungeon* were built on full GPT models, trained on content from sites focused on interactive gamebooks. This leverages machine learning to offer near complete control of the story.

The game prompts players to choose a genre, such as fantasy or cyberpunk. After the adventure begins, the game will respond to any action or speech the player enters. It also supports a 'story' mode, where players can have the game remember key plot details, such as that a particular door is unlocked.

This is easy to achieve, as *AI Dungeon* is text-based. Currently, there are no commercial graphical titles using machine learning to dynamically craft NPC responses and missions in response to user input.

In 2023, Replica Studios gave gamers a taste of things to come with a demo of its 'Smart' NPC plugin for Unreal Engine 5. In theory, this can be powered by OpenAI or a developer's own language model to make NPCs react in a more realistic way, creating more immersive stories.

Shortly after its release, videogame enthusiast Trevor Martin put the plugin to the test in a vast simulated city by approaching Smart NPCs and trying to convince them that they were living in a simulation. Though we wouldn't encourage readers to try this in real life, the NPC responses were quite plausible. In most cases Martin wasn't believed. Other NPCs resolved to continue living their 'best life', despite knowing they weren't real.



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1 AMD'S FINEST

The literal game changer here is AMD's new Strix Point APU. That means fully 12 CPU cores, including four Zen cores and eight Zen 5c cores. But it's the 16 compute units of upgraded RDNA 3.5 graphics that makes this chip really special for handheld gaming. It's a major graphical upgrade over any previous APU from AMD.

OneXPlayer OneXFly F1 Pro

IF YOU'RE a handheld fan, prepare to be a smitten kitten. No, not because of the fetching red clothing of this version of the new OneXFly F1 Pro. This colorway indicates the Evangelion EVA-02 version, which isn't available outside of China. No, the real kicker is that this is the first gaming handheld PC we've got our paws on that sports AMD's latest APU, the Ryzen AI 9 HX 370. Yup, it's AMD's Strix Point chip in a handheld.

That new silicon is a bit of a game changer for handhelds, especially when you start to factor in all the other extras AMD has crafted that really play into the literal hands of PC gamers. Radeon Anti-Lag and Fluid Motion Frames 2 really are the key ones for handheld gaming, but also any game that sports FSR3 and its own per-game frame generation implementations, too.

As for the design and aesthetics, these are largely carried over from the original OneXFly F1. That is no bad thing, because the slightly rubberized texture and smooth curves of the chassis feel great. Sadly, the 48.5Wh battery has been carried over, too. It was too small for a convincing long-term gaming experience with the OG OneXFly, so that's unlikely to have changed.

Still, that new AMD chip really sets it apart, as does the $1,339 price tag. The kind of cash that gets you a full RTX 4070 Super gaming PC and still leaves you with enough change for a decent gaming monitor, too. So yeah, you've got to really want the handheld form factor to justify that kind of spend. **–MAXIMUM PC**

2 LOOKS FAMILIAR?

Ignore the bright red threads of the limited China-only edition, and the design and aesthetics of the new OneXPlayer OneXFly F1 Pro are largely carried over from the original OneXFly F1. But we're not complaining, because the rubberized surface texture and pleasingly smooth curves of the OG chassis felt great in your hands.

3 BATTERY BUMMER

With the original OneXFly F1, it was only the 48.5Wh battery that disappointed. Sadly, that's been carried over for this new model, so it's likely that you're going to need to get an external power pack to be able to enjoy this on the go for more than an hour and a half. It's a pity, but so it goes in high-performance handheld territory.

wallhaven
Latest
Hot
Toplist
Random
Upload
Forums
More
Search...
General
Anime
People
AI Art
SFW
Sketchy
≥ 3440×1440
21 × 9
Color
Random
Register
Login
2,723 Wallpapers found
Find more search options above!
At Least
Exactly
Your screen resolution is 3440 × 1440.
Ultrawide
16:9
16:10
4:3
5:4
Custom Resolution
Width
Height
AOC

There are over 1,500 Ultrawide 21:9 3440x1440 wallpapers on this site under the general tag.

PART TWO

THE ULTIMATE WINDOWS 11 INSTALL GUIDE

Install our favorite OS like Maximum PC veteran Zak Storey does it

© WALLHAVEN

Ah, Windows 11, you old devil. Microsoft's latest iteration of its operating system line might be quite contentious these days, filled with advertising, data scraping, and enough bugs to make even a Tyranid Hive Fleet jealous, but it's nothing if not a consistent thread throughout our custom PC building life.

It represents the ultimate middle-ground OS—versatile and customizable enough to outpace the very best of MacOS, yet with more than enough compatibility and stability to give any Linux distro a run for its money. If you just want to get an install up and running quickly, tailored just how you like it, and compatible with 99.9 percent of all the programs out there, then Windows is the place to be.

That said, it's not without its pitfalls. In our anecdotal experience, we often find that Windows OS seems to degrade over time. Performance falters, registry keys become corrupt, driver updates fail, and unnecessary background processes and programs hog resources that would be better used elsewhere. It's almost become a *Maximum PC* tenet, but seriously, if you're not already, you should consider reinstalling your Windows OS every three to six months. It's on the same level as 'it's probably memory' and 'have you tried turning it off and on again' in our most repeated PC troubleshooting phrases.

Not only will you get a clean install, it'll also give you the opportunity to throw out any old programs and keep everything running nice and smoothly in the meantime.

There are also a lot of customization tweaks you can do with the modern form of Windows. As always, your own install will inevitably be unique to you, designed for your needs, but today we're going to share with you just how we here at *Maximum PC* install Windows on everything from our personal machines to test systems and beyond. We'll cover our general install process, what tweaks we perform, how we configure it to maximize its utility, and tips on how to streamline its efficiency, leaving you with an ultra-slick desktop that's perfect for anything you throw at it. Let's dive back in, shall we?

MAXIMUM PC'S TIPS AND

HOW TO FINE-TUNE YOUR DESKTOP EXPERIENCE

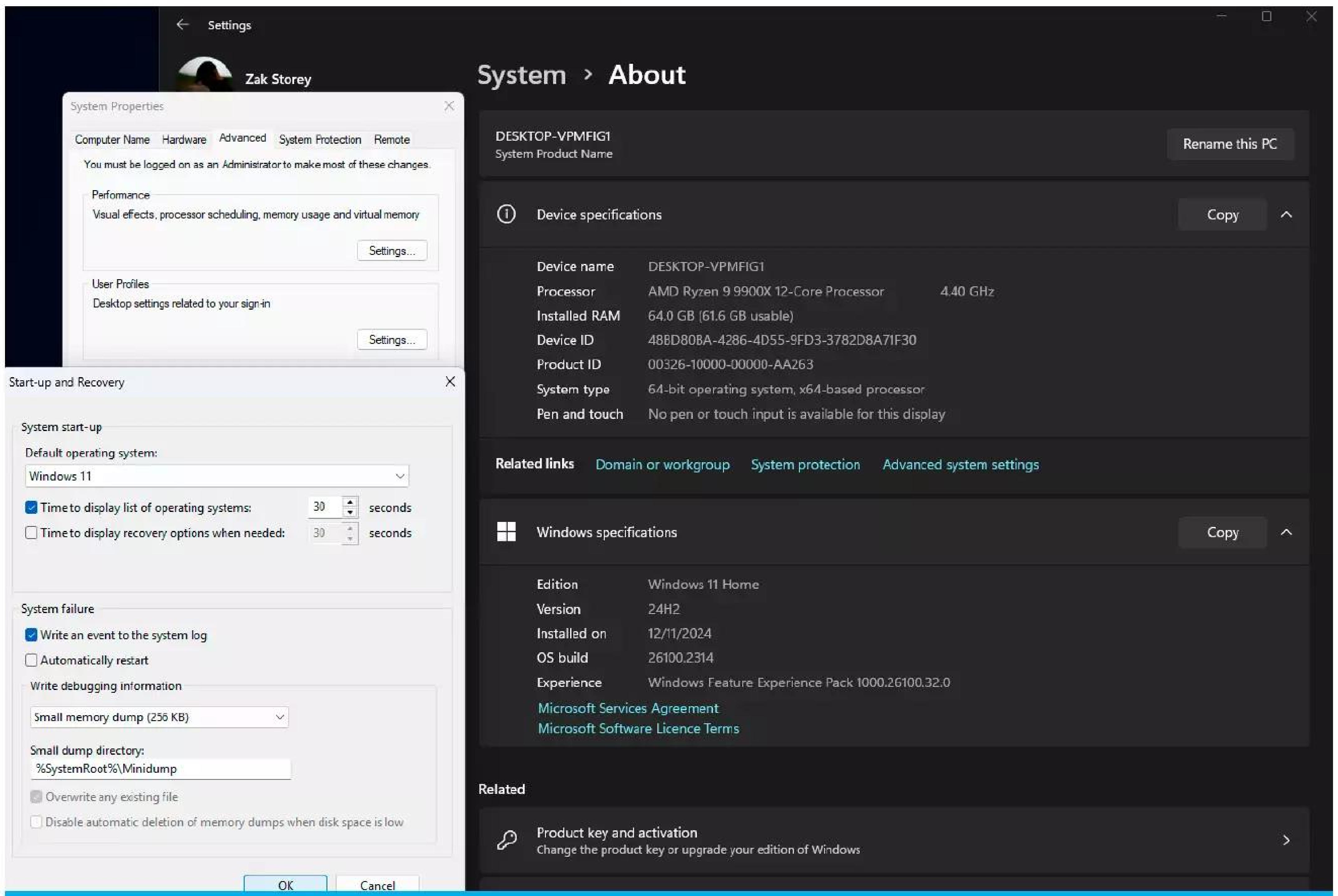
TWEAK

Armoury Crate, DriverHub, et al

With Windows installed and your network connected (see Part One last issue), a variety of programs will start popping up with auto-installers. Asus, for example, will have DriverHub and Armoury Crate. DriverHub is incredibly useful, as it will point you toward missing installs and new versions of any chipset or drivers you're missing.

That said, if you hit 'Install all', it will also install a bunch of crud that we don't want, such as Norton 360 Antivirus, AIDA64, and other superfluous programs. The same goes for MSI and Gigabyte, so be wary no matter what your motherboard.

Now that we've done the majority of the legwork on our driver updates and clean install process, it's time to tighten up the system a bit and proceed with a few quick fixes. The first thing is going to be updating the time.


Settings
Zak Storey
System Properties
Computer Name
Hardware
Advanced
System Protection
Remote
Settings...
Settings...
Start-up and Recovery
OK
Cancel
System › About
Rename this PC
Copy
Copy
Related links
Domain or workgroup
System protection
Advanced system settings
Microsoft Services Agreement
Microsoft Software Licence Terms
Related

You must be logged on as an Administrator to make most of these changes.

Performance
Visual effects, processor scheduling, memory usage and virtual memory

User Profiles
Desktop settings related to your sign-in

System start-up
Default operating system: Windows 11
☑ Time to display list of operating systems: 30 seconds
☐ Time to display recovery options when needed: 30 seconds

System failure
☑ Write an event to the system log
☐ Automatically restart
Write debugging information
Small memory dump (256 KB)
Small dump directory: %SystemRoot%\Minidump
☑ Overwrite any existing file
☐ Disable automatic deletion of memory dumps when disk space is low

DESKTOP-VPMFIG1
System Product Name

Device specifications
Device name DESKTOP-VPMFIG1
Processor AMD Ryzen 9 9900X 12-Core Processor 4.40 GHz
Installed RAM 64.0 GB (61.6 GB usable)
Device ID 48BD80BA-4286-4D55-9FD3-3782D8A71F30
Product ID 00326-10000-00000-AA263
System type 64-bit operating system, x64-based processor
Pen and touch No pen or touch input is available for this display

Windows specifications
Edition Windows 11 Home
Version 24H2
Installed on 12/11/2024
OS build 26100.2314
Experience Windows Feature Experience Pack 1000.26100.32.0

Product key and activation
Change the product key or upgrade your edition of Windows

Stop those pesky system crash restarts.

TIP

Time dilation

For whatever reason, the time-zone settings are always buggy with your first install. Head to the Start menu, type 'Date and Time', and select the top option. Once in the Date & Time menu, uncheck and recheck 'Set the time zone automatically' and 'Set the time automatically' below it. This should then force Windows to sync with the internet and your time zone/IP, and get the right time (this is important for Windows updates and certain two-factor authentication methods).

TWEAK

PowerPlan edits

Are you vain like us? Do you like showing off your sexy rig when you've got guests, or do you just like to admire your desktop's beauty as you're using it? Then a quick PowerPlan edit is for you. Go to the Start menu, type

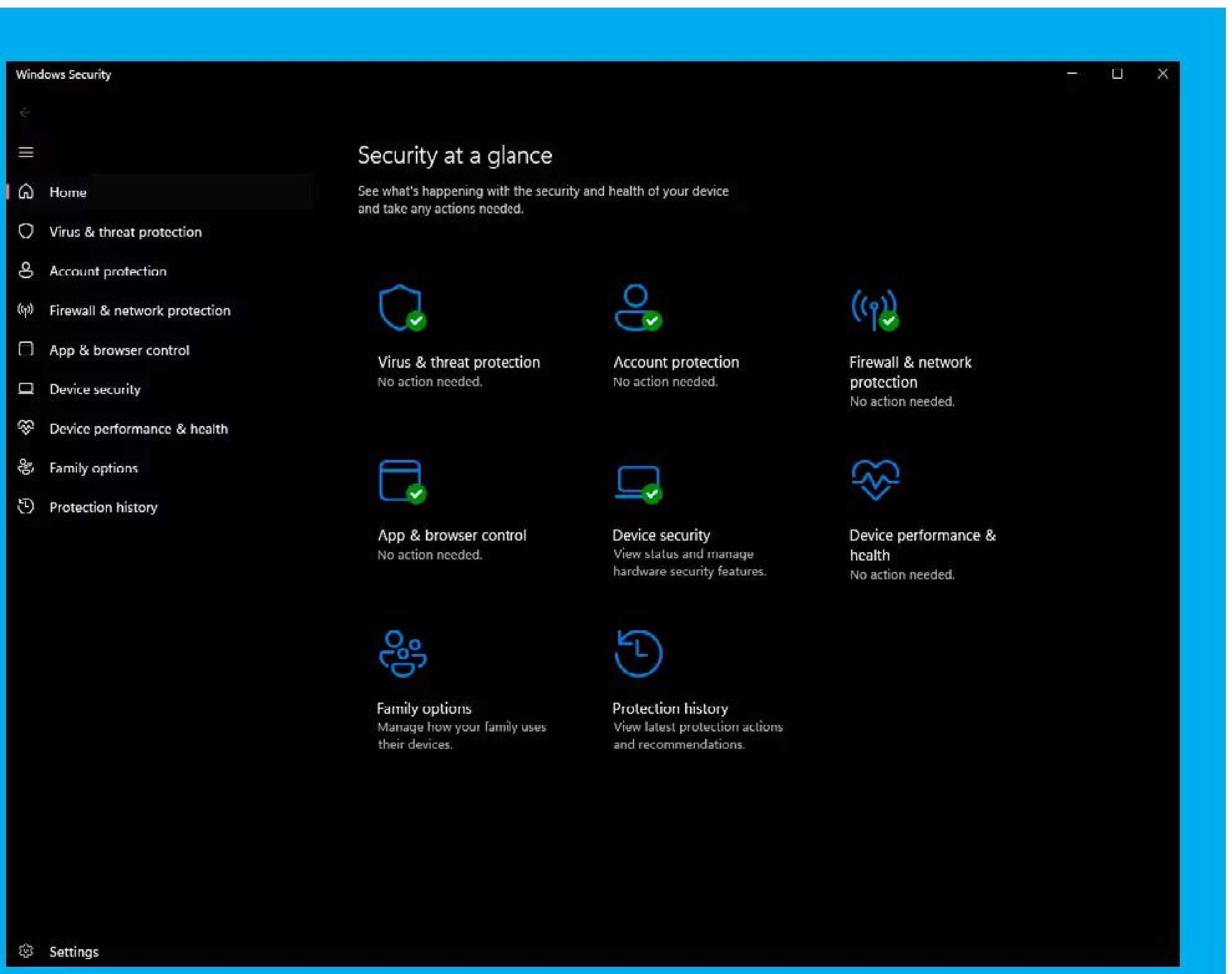
THE BEST ANTIVIRUS

It's Windows Defender. It just is. No, honestly, the best defense you have against bad actors on the internet and other malicious code is good internet practices. Don't open attachments from random emails, click dodgy links, or download suspect programs, and you'll be golden. If the worst comes to the worst, you can just flatten your system and reinstall your OS.

Most aftermarket antivirus programs cause all manner of conflicts and issues on many of the PCs we've worked with over the years, sucking up valuable system resources, causing conflicts, and even outright stopping all manner of programs from running efficiently (even some of our benchmarking programs). We've seen them delete system files, parts of programs, and other benign applications on a whim, stop them from running, or crashing entire systems after Windows updates. The reality is that 99 percent of the time, they're just not worth running.

Sure, Malwarebytes is useful every now and then for a quick sweep, but Windows Defender is one of the most up-to-date and unobtrusive antivirus programs out there, and it's built into your operating system, doesn't take up valuable resources, and generally just works.

You do not need aftermarket antivirus, so save yourself the subscription fee, and grab a VPN instead.


Windows Security
Home
Virus & threat protection
Account protection
Firewall & network protection
App & browser control
Device security
Device performance & health
Family options
Protection history
Settings

Security at a glance
See what's happening with the security and health of your device and take any actions needed.

Virus & threat protection
No action needed.

Account protection
No action needed.

Firewall & network protection
No action needed.

App & browser control
No action needed.

Device security
View status and manage hardware security features.

Device performance & health
No action needed.

Family options
Manage how your family uses their devices.

Protection history
View latest protection actions and recommendations.

© MICROSOFT

TWEAKS

'Edit PowerPlan', click the option, change 'Put the computer to sleep' to Never, and 'Turn of the display' to 3 Hours. Now, you can enjoy your rig for a little longer. Just remember to turn it off when you're done. This is also really useful if you want to download programs and games overnight.

TIP

Stop error restarts

Have you ever shut down your system before going to sleep with updates, and woke up to the thing still turned on in the morning? Yeah, it's a pet peeve of ours, too. This is to do with how Windows manages its system failures, where it will automatically restart if something goes wrong. This can be as simple as an update taking too long, or failing and fixing itself on the restart. To stop this, go to Settings, then System, then About. Once here, click the 'Advanced system settings' option. Then, under 'Start-up and Recovery', hit the 'Settings...' button. Under 'System failure', uncheck 'Automatically Restart' and hit 'OK', and you'll be good to go.

TIP

Tidy the taskbar

We're not fans of that centralized Start menu—it's just not for us. Nor are we fans of all the stuff that Microsoft has chucked on here, too. Right-click the task bar, and open 'Taskbar Settings'. If you're like us and prefer to use keyboard shortcuts, disable 'Task view' and 'Widgets', and hide the 'Search' option. Then, click the 'Taskbar behaviors' tab, and choose 'Left' for taskbar alignment.

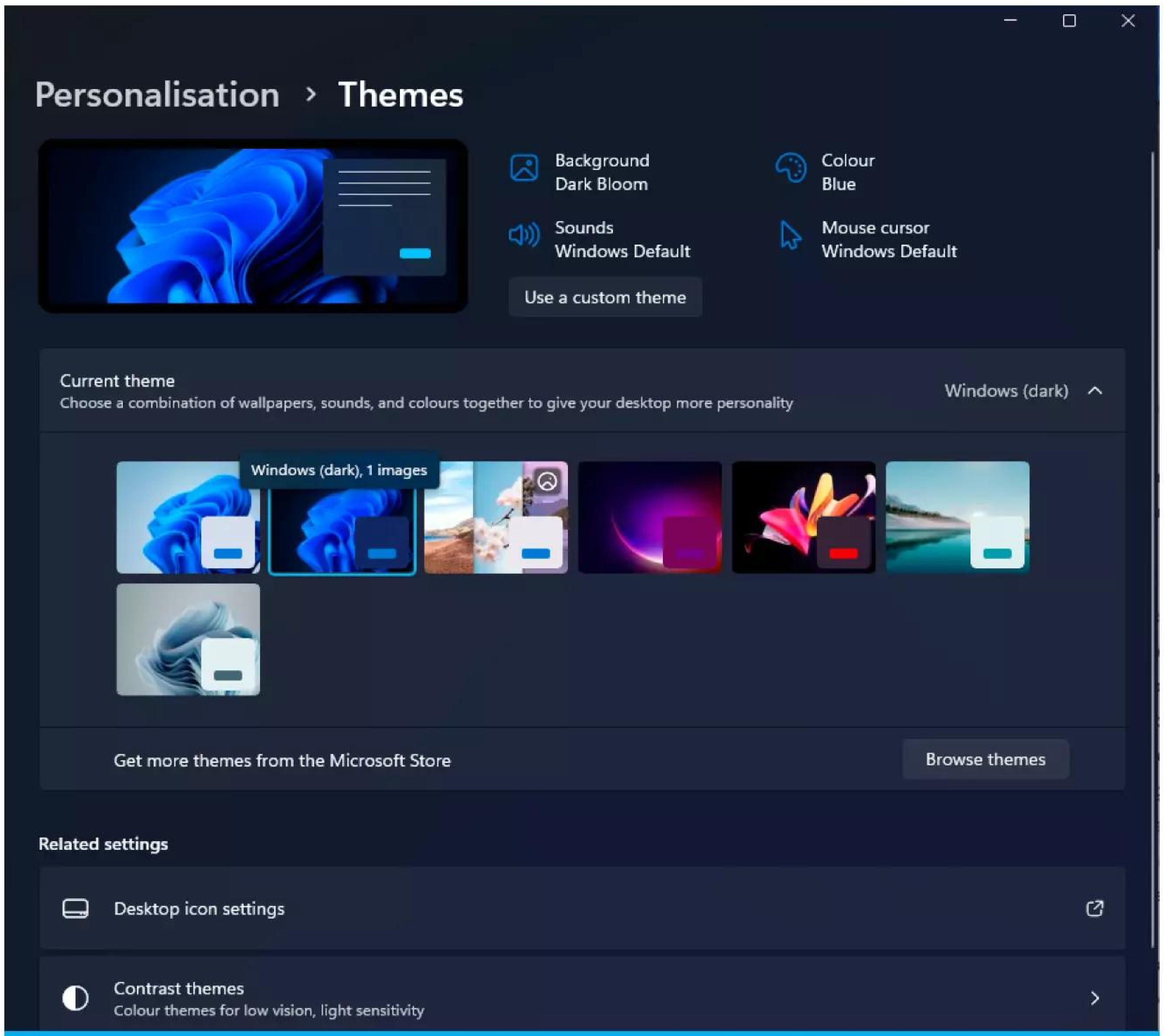
We will also be removing a few of the fluff programs that Windows chucks on here. Right-click Copilot and unpin it, along with the Microsoft Store. You can leave Edge for the time being, as we'll need it to unceremoniously install Google Chrome and others in a moment.

TWEAK

Theme and mouse settings

Right-click Desktop, and hit Personalization. Go to Themes, and select the second most dark theme for a nice, clean dark mode option for your desktop. We'll be changing the wallpaper later, but this just brings the intensity of those bright screens down when we're working on projects late at night. While we're here, we're also going to adjust our mouse cursor. Select the 'Mouse cursor' option on the top right. This will open an old-school 'Pointers' menu.

Here, we're going to choose the 'Windows Black (system scheme)' for our mouse pointer. This might sound a bit insane, but it makes spotting the mouse on larger screen setups far easier. This is particularly useful if you're using ultra-wide or 4K panels in conjunction. The number of times we've lost a white mouse pointer on those things is troubling.



Personalisation › Themes

Background
Dark Bloom

Colour
Blue

Sounds
Windows Default

Mouse cursor
Windows Default

Use a custom theme

Current theme
Choose a combination of wallpapers, sounds, and colours together to give your desktop more personality
Windows (dark)

Windows (dark), 1 images

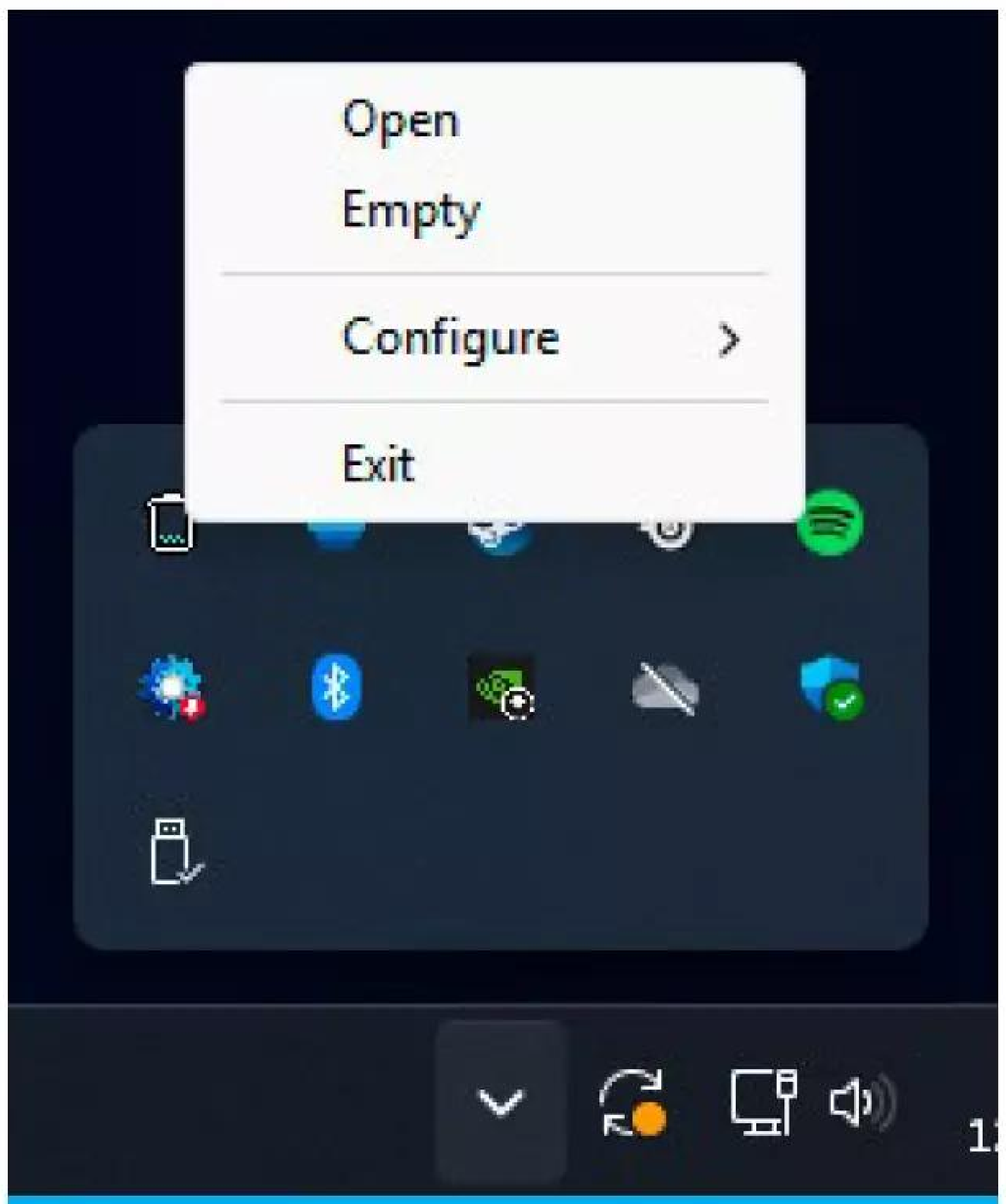
Get more themes from the Microsoft Store
Browse themes

Related settings

Desktop icon settings

Contrast themes
Colour themes for low vision, light sensitivity

There's so much more to customization here than you realize.



It's a simple and elegant solution for your recycling bin needs.

© MINIBIN

TIP

Desktop icons and minibin

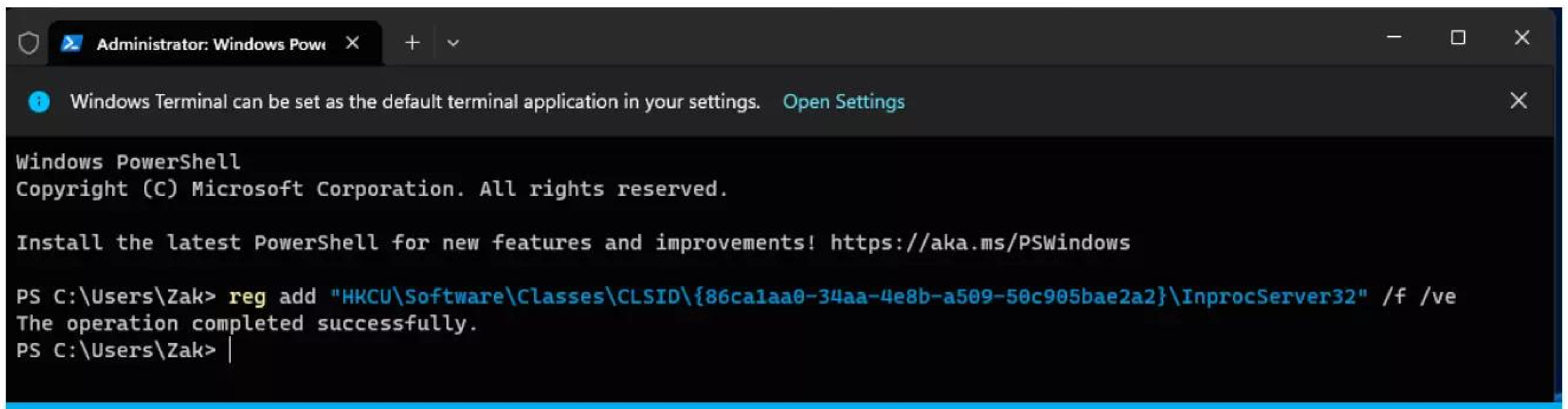
While we're still in the Themes setting, select 'Desktop icon settings' and uncheck the 'Recycle Bin' desktop icon. We're going to be replacing our recycling bin with a third-party program that makes everything a lot slicker. Hit Apply—this will hide it from your desktop.

Then, head to Google and search 'Minibin Download'. Go to Major Geeks (www.majorgeeks.com), and download MiniBin 6.6.0.0. Run and install it, and a bin icon will appear in your hidden icons menu on the bottom right. Right-click it, select 'Configure', then 'Icon double-click action', and ensure that it's set to 'Open' rather than 'Empty'. Delete the programs and links off your desktop, and you should have a completely empty setup.

TIP

Monitor tweaks

We've all fallen foul of this at one point or another—you have that 240Hz refresh rate monitor, but accidentally use it at 60Hz for a good long


Administrator: Windows Powe

Windows Terminal can be set as the default terminal application in your settings. Open Settings

```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\Zak> reg add "HKCU\Software\Classes\CLSID\{86ca1aa0-34aa-4e8b-a509-50c905bae2a2}\InprocServer32" /f /ve
The operation completed successfully.
PS C:\Users\Zak> |
```

There's nothing like a bit of regedit in PowerShell to get a decent right click menu back.

while. Head to 'Settings', then 'System', then 'Display', select the monitor you want to configure, scroll down to 'Advanced display', then 'Choose a refresh rate', and select the highest refresh rate you can. Just a heads up: you won't be able to do this prior to installing your graphics driver.

If you're running twin monitors at odd angles like we are, another setting to turn off here in 'Multiple displays' is 'ease cursor movement between displays'. This makes it so you can finely calibrate the gap and movement path for your mouse cursor to pass between the two displays, by shifting them in the window above. This is insanely useful if you like snapping programs to each side of the screen.

TWEAK

Night Light

Another neat feature is Windows' built-in Night Light solution. To make things a little bit more tolerable on your eyes during low-light situations, you can get Windows to naturally increase the warmth of your displays as the sunsets, and brighten them on Sunrise.

Click the Start menu, then type 'Night Light' and go into the settings. Check the box to allow Night Light to schedule based on sunset and sunrise, then adjust the strength to your liking, and you'll be golden—literally (at least, your screen will be).

TIP

Right-click Power menu

When it comes to the right-click menu in general, hitting 'More options' all the time gets pretty tiresome. Fortunately, you can disable the first menu and go directly to that Power menu instead if you want to with every right click. To do this, go to the Start menu and right-click it, then select ;Terminal (admin)'. Once Windows PowerShell has opened up, type in the following, and hit Enter:

```
“HKCU\Software\Classes\CLSID\
{86ca1aa0-34aa-4e8b-a509-
50c905bae2a2}\InprocServer32” /f /ve
```

Once PowerShell registers that the operation completed successfully, go to Task Manager, find Windows Explorer, and restart it. You'll now have the right-click menu from Windows 10 back.

TIP

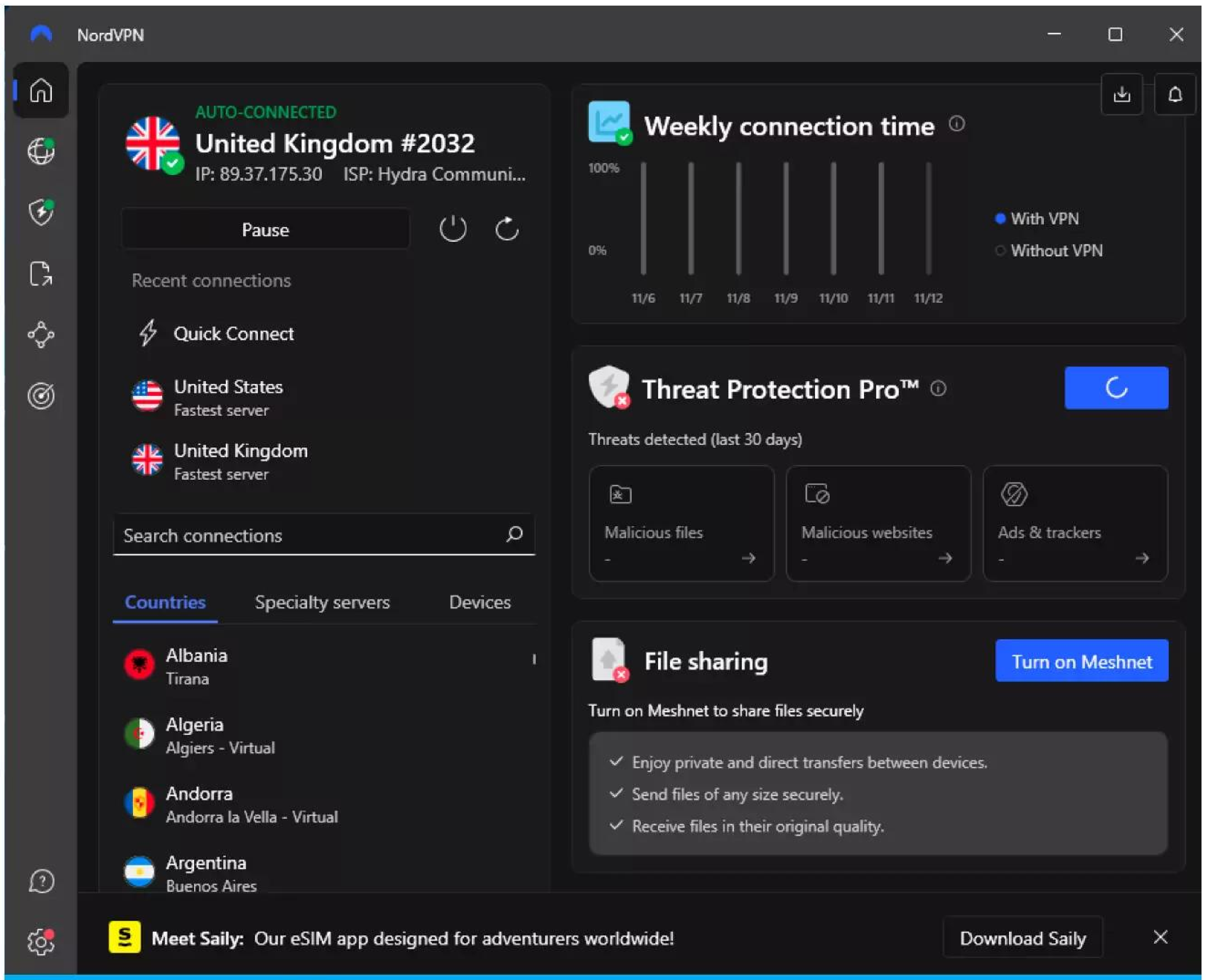
Programs and Ninite

With our arsenal of quick fixes in place, it's now time to get Ninite in. Open up Edge, and (once you're past the initial interrogation it likes to put you through) head to ninite.com. Here, we're going to download all the programs we need. For us, we typically install Chrome, Firefox (as a back-up browser), Zoom, Discord, Skype, WinRAR, Spotify, Notepad++, and Steam. Let that run, and download everything you need.

With that done, log in to Chrome and enable Sync. This will pull all your Google Chrome plugins, settings, cookies, and more across, saving you a ton of time in the process. We're also going to start installing all our other programs. In our case, that will be our benchmarking tools (CrystalDiskMark, Cinebench, and *Final Fantasy XIV* tests are all fantastic free options), along with HWMonitor, Adobe CC, all the game launchers we need, our batch of Elgato programs, and whatever else we'll need day-to-day.

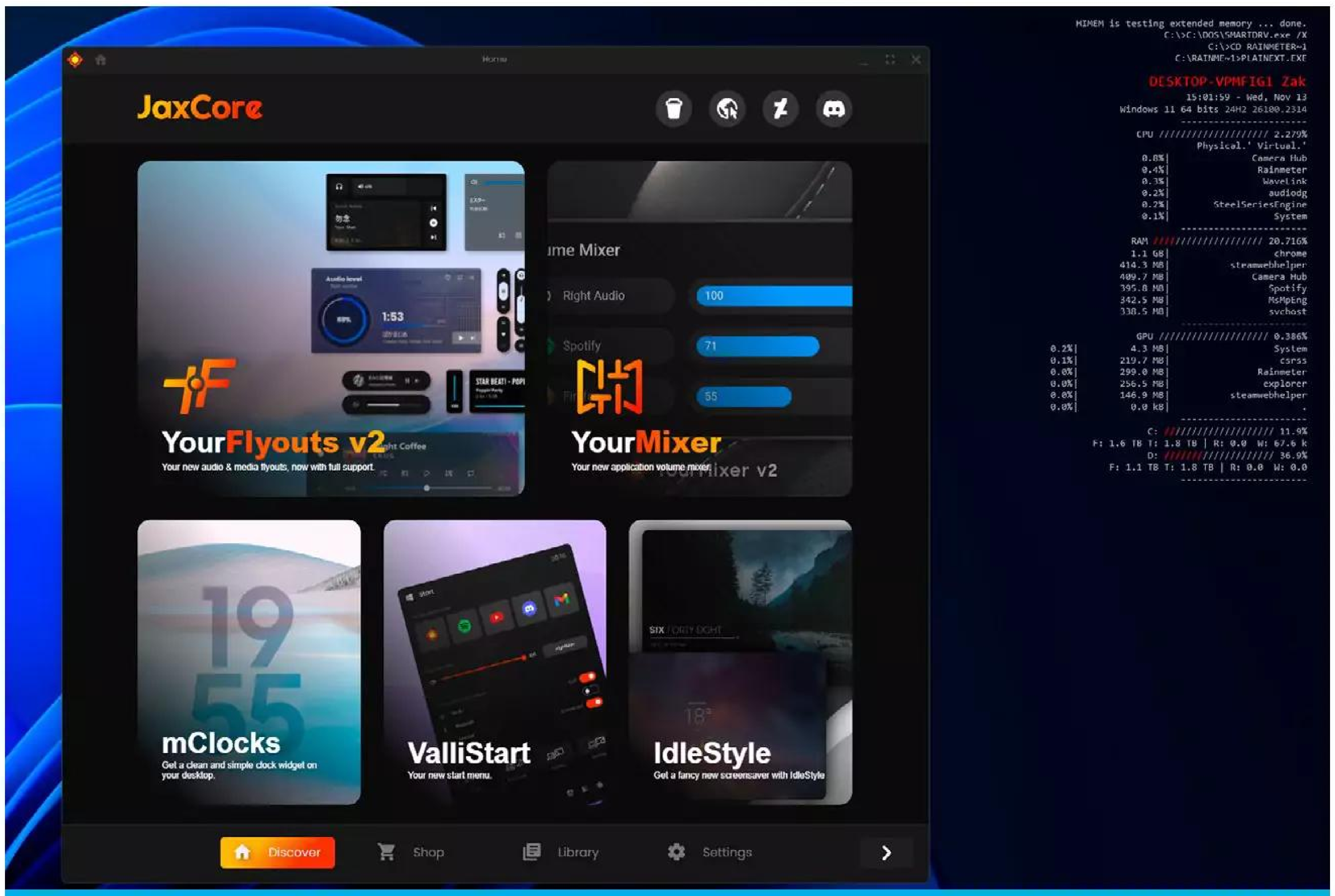
We're also going to take the opportunity to log in to all the programs and sites that we need to, and install our VPN of choice. The vast majority of VPNs out there these days are top-tier—we highly recommend that you grab one for your internet safety, whether that's ExpressVPN, NordVPN, Surfshark, Proton VPN, or something else. Find the one with the best deal (there are almost always offers), and get that thing installed and loading up with Windows minimized every time. With NordVPN, we ensure that it auto-connects with an internet kill switch and starts with Windows on startup minimized.

We also log in to Skype and Discord, and set their options to not start or load with Windows launch (they're both notorious for ignoring startup menu commands), as we only need them occasionally. Next, we're going to want to log in to Steam and find our D: drive games. To do that, go to 'Steam' in the top left, 'Settings', then 'Storage', and add a new drive. Select your 'Local Drive (D:)', and Steam will then scan and identify any installed games there too. This also works with EA and Battle.net. Sadly, Epic will automatically redownload games no matter what, and Ubisoft's launcher takes an age to verify the files, but technically doesn't redownload.


NordVPN
AUTO-CONNECTED
United Kingdom #2032
IP: 89.37.175.30 ISP: Hydra Communi...
Pause
Recent connections
Quick Connect
United States
Fastest server
United Kingdom
Fastest server
Search connections
Countries
Specialty servers
Devices
Albania
Tirana
Algeria
Algiers - Virtual
Andorra
Andorra la Vella - Virtual
Argentina
Buenos Aires
Weekly connection time
100%
0%
11/6
11/7
11/8
11/9
11/10
11/11
11/12
With VPN
Without VPN
Threat Protection Pro™
Threats detected (last 30 days)
Malicious files
Malicious websites
Ads & trackers
File sharing
Turn on Meshnet
Turn on Meshnet to share files securely
Enjoy private and direct transfers between devices.
Send files of any size securely.
Receive files in their original quality.
Meet Saily: Our eSIM app designed for adventurers worldwide!
Download Saily

Ensuring you have a VPN correctly set up is a pivotal privacy measure.

© MICROSOFT, NORDVPN


JaxCore
YourFlyouts v2
Your new audio & media flyouts, now with full support
YourMixer
Your new application volume mixer
mClocks
Get a clean and simple clock widget on your desktop.
ValliStart
Your new start menu.
IdleStyle
Get a fancy new screensaver with IdleStyle
Discover
Shop
Library
Settings

JaxCore and Rainmeter help add a bit of pizazz to your desktop life.

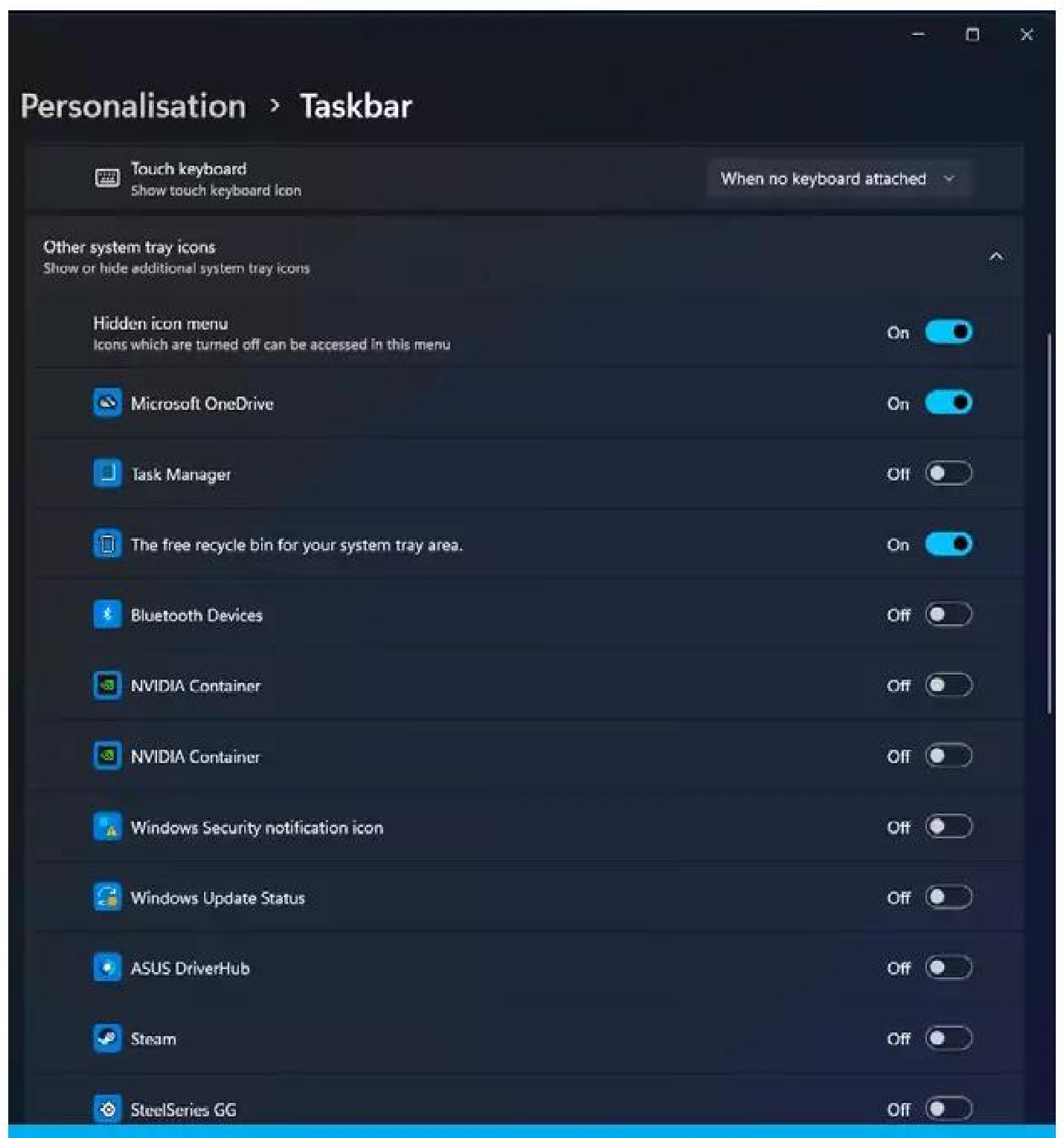
Pin the programs you need to your taskbar, or your start menu, and we're close to being finished.

TWEAK

Rainmeter & JaxCore

We've got a final few tweaks to really make our desktop shine. First up is getting Rainmeter installed. Rainmeter allows you to posit third-party widgets on your desktop. These are insanely useful, as Windows doesn't, for some reason, have a suitable solution for this just yet. Head to rainmeter.net, and download the latest release build.

As standard, it comes with a fairly generic skin. You can unload those widgets by right-clicking them and selecting the expanded option. Double-click the Rainmeter icon in your icons tray, and you'll find all the loaded skins as well.



Personalisation › Taskbar

Touch keyboard
Show touch keyboard icon
When no keyboard attached

Other system tray icons
Show or hide additional system tray icons

Hidden icon menu
Icons which are turned off can be accessed in this menu
On

Microsoft OneDrive On
Task Manager Off
The free recycle bin for your system tray area. On
Bluetooth Devices Off
NVIDIA Container Off
NVIDIA Container Off
Windows Security notification icon Off
Windows Update Status Off
ASUS DriverHub Off
Steam Off
SteelSeries GG Off

It's well worth dropping MiniBin and your VPN onto your taskbar icons list.

In our case, however, we're going to be using a widget suite called JaxCore to provide us with what we need (in this case, system monitoring, clocks, and media flyouts). Head to jaxcore.app, and download the latest version.

It will run a PowerShell script to install. Once in, you want to install Plainext, YourFlyouts, and ModularClocks. There's a whole host of configuration you can do here, all of which is fairly self-explanatory. There are a number of Rainmeter skins that look a treat, too, if you're not a fan of JaxCore's work. Check out the official site, Discord Art, and Reddit for those.

We're also going to pair this with some beautiful wallpaper. There are a few places to get decent wallpaper from, but we love wallhaven.cc the most. You can find all manner of wallpapers here (there are around 1.2 million wallpapers). Click Random at the top, then deselect the tabs you don't want to see. What's unique about Wallhaven is that you can select a number of filters, including resolution and aspect ratio, then filter them appropriately. Find the right settings for your screen, then search a keyword, or scroll down the list and find some truly top-tier wallpapers.

TWEAK

Final taskbar tweaks and startup speed

With all of our programs installed and ready to go, we're going to have a final pass at our taskbar icons. Head back to Taskbar settings by right-clicking it and hitting Settings, then click the 'Other system tray icons' menu. Here, you'll find a list of all the programs you have running that are currently hidden. You can toggle them on or off to appear on the bottom right of the taskbar. We highly recommend toggling Minibin and your VPN of choice here, as it makes it far more easy to access them if you do so.

With that, we're then going to task a final pass at our start-up programs as well. Search 'Startup' in the same settings menu, and it'll take you to a list of all the apps you have installed. Go down the list, and disable anything that's intrusive or you don't always need on launch. Then go into Task Manager, find the same menu, and ensure you've not missed anything. With that, you'll finally be finished. Welcome to your *Maximum PC*-approved, slick, and super-clean desktop. ⏻

HOW DO YOU USE THIS THING?

Simply put, your desktop is your workspace. This is where files you're working with or on during the day or at that moment should be placed—a temporary space while you complete projects. Once you're wrapped up with them, delete them, upload them, back them up, or clean them off your desktop.

The taskbar is where your most frequently used programs are found. These can include games—Spotify, web browsers, Photoshop, the works. The less you have on here, the better. The programs in your Start menu should be less frequently used programs, but still mission-critical. In our case, these are system monitoring tools, benchmarks, audio and camera control, and general setting programs. The hidden taskbar icons are there for everything else.

Game launchers are, ironically, fantastic clean-up tools, too. Instead of having 14 different titles on your taskbar, desktop, or start menu, they're all held in a single launcher. Open that up, and use it that way.

Alternatively, Windows search is your friend. Need a program, but can't remember where you put it? Click the Start menu, and start typing to find it. It's a super-quick and easy way to discover any and all programs you might need.

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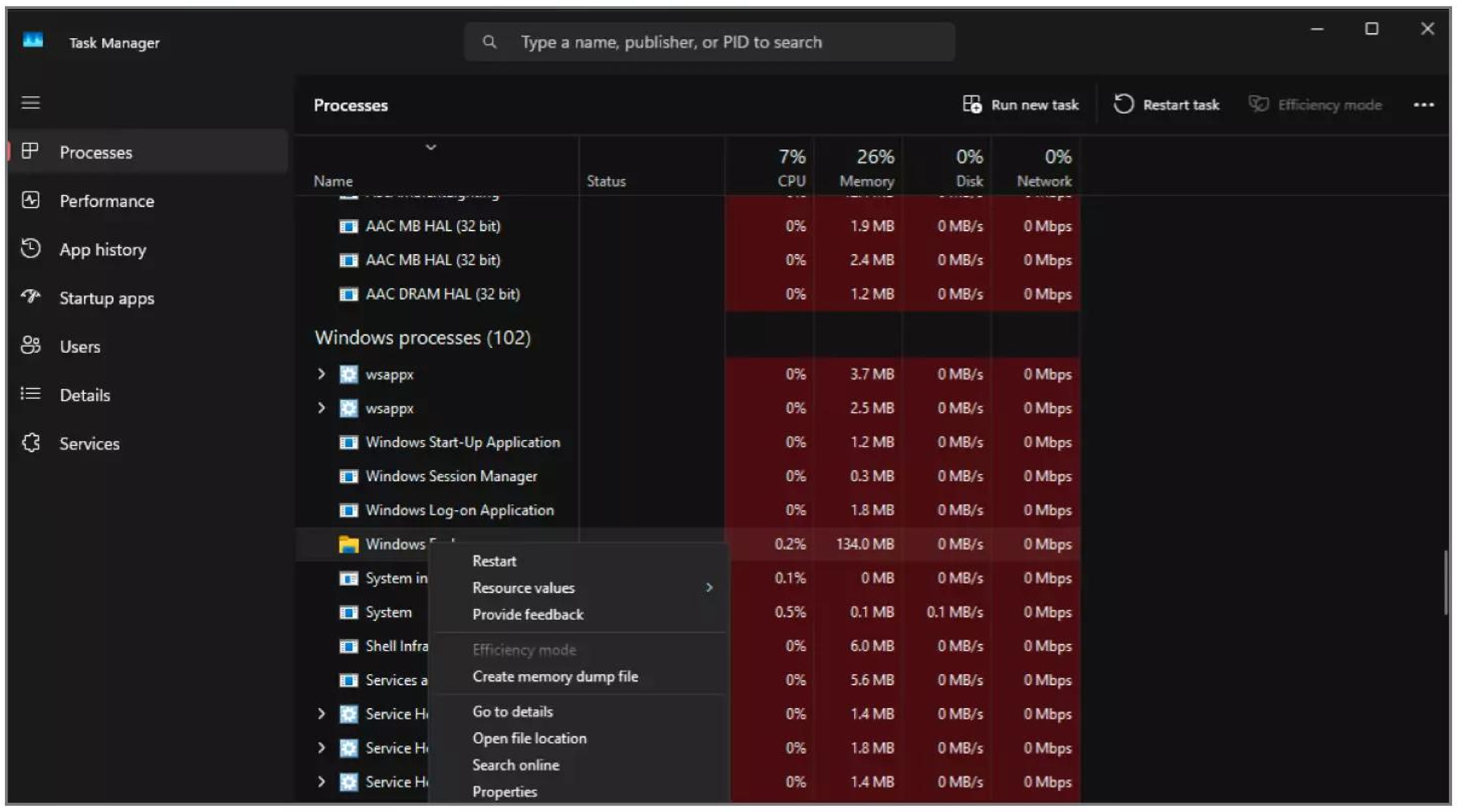
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH


Task Manager
Type a name, publisher, or PID to search
Processes
Performance
App history
Startup apps
Users
Details
Services
Run new task
Restart task
Efficiency mode
Restart
Resource values
Provide feedback
Efficiency mode
Create memory dump file
Go to details
Open file location
Search online
Properties

Processes

Name	Status	7% CPU	26% Memory	0% Disk	0% Network
AAC MB HAL (32 bit)		0%	1.9 MB	0 MB/s	0 Mbps
AAC MB HAL (32 bit)		0%	2.4 MB	0 MB/s	0 Mbps
AAC DRAM HAL (32 bit)		0%	1.2 MB	0 MB/s	0 Mbps
Windows processes (102)					
wsappx		0%	3.7 MB	0 MB/s	0 Mbps
wsappx		0%	2.5 MB	0 MB/s	0 Mbps
Windows Start-Up Application		0%	1.2 MB	0 MB/s	0 Mbps
Windows Session Manager		0%	0.3 MB	0 MB/s	0 Mbps
Windows Log-on Application		0%	1.8 MB	0 MB/s	0 Mbps
Windows E		0.2%	134.0 MB	0 MB/s	0 Mbps
System in		0.1%	0 MB	0 MB/s	0 Mbps
System		0.5%	0.1 MB	0.1 MB/s	0 Mbps
Shell Infra		0%	6.0 MB	0 MB/s	0 Mbps
Services a		0%	5.6 MB	0 MB/s	0 Mbps
Service H		0%	1.4 MB	0 MB/s	0 Mbps
Service H		0%	1.8 MB	0 MB/s	0 Mbps
Service H		0%	1.4 MB	0 MB/s	0 Mbps

WINDOWS EXPLORER RESTART

Sometimes, things go wrong with the Start menu, with File Explorer, with my computer. It will lock up and freeze, or lag out. It happens. Windows can be a fickle thing. Don't panic, though; it might not require a hard restart. Instead, hit Ctrl-Alt-Delete, head to Task Manager, and find Windows Explorer in the process list. Right-click, hit restart, and hopefully it will resolve your taskbar issues.

MAKE – USE – CREATE

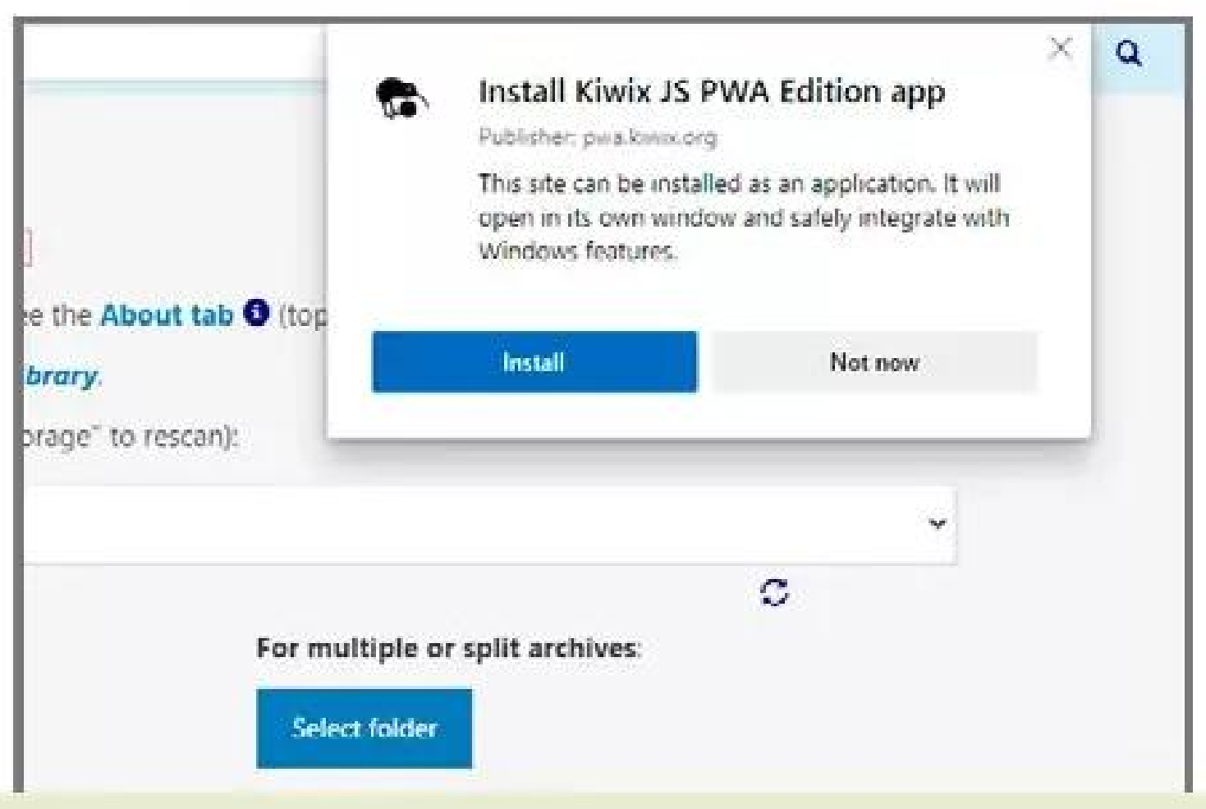
Windows Security
More choices

Making sure it's you

Sign in with Windows Hello to use Recall and access your snapshots.

Hello, [redacted]
Select OK to continue.

60
Improve your memory with Windows Recall


Install
Not now
Select folder

Install Kiwix JS PWA Edition app

Publisher: pwa.kiwix.org

This site can be installed as an application. It will open in its own window and safely integrate with Windows features.

e the About tab (top
ibrary.
orage" to rescan):

For multiple or split archives:

64
Create your own offline data vault

68
Boost your Wi-Fi performance

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ZAK STOREY
CONTRIBUTOR

LG GRAM PRO 16 RESULTS

Last issue, I had the joy of looking at the LG Gram 16 (page 80). Despite being a bit dubious on the build quality, I was impressed.

However, it was very much a last-minute addition to the reviews segment, to the point that I couldn't quite get all the benchmarks wrapped up in time (such is the curse of deadlines).

I've had a bit of time to get to grips with it, and can report that it's fairly average across the board. Cinebench reported 98 on the single-core and 619 on the multi-core. Geekbench landed at 2,087 and 12,699 on the multi-core here. That'd be fine if it wasn't for the fact that Acer's Swift Go 14 manages similar, but costs less.

Similarly, gaming on the RTX 3050 was what you'd expect, with frame rates sitting around 37.3fps in *Total War* at 1080p and 35.1fps in *Cyberpunk* with DLSS enabled. Battery life performed admirably, with the video test at around 322 minutes at 50 percent brightness.

Is it still an 8? Yup. This laptop, although Pro in name, is more for the showy professional who needs something to handle larger documents. It's not by any means a gaming notebook or rendering titan, but that's okay. That form factor severely limits it, and trying to pair it with hotter and greater hardware still feels like a bit of a swing and a miss.

↘ submit your How To project idea to: editor@maximumpc.com

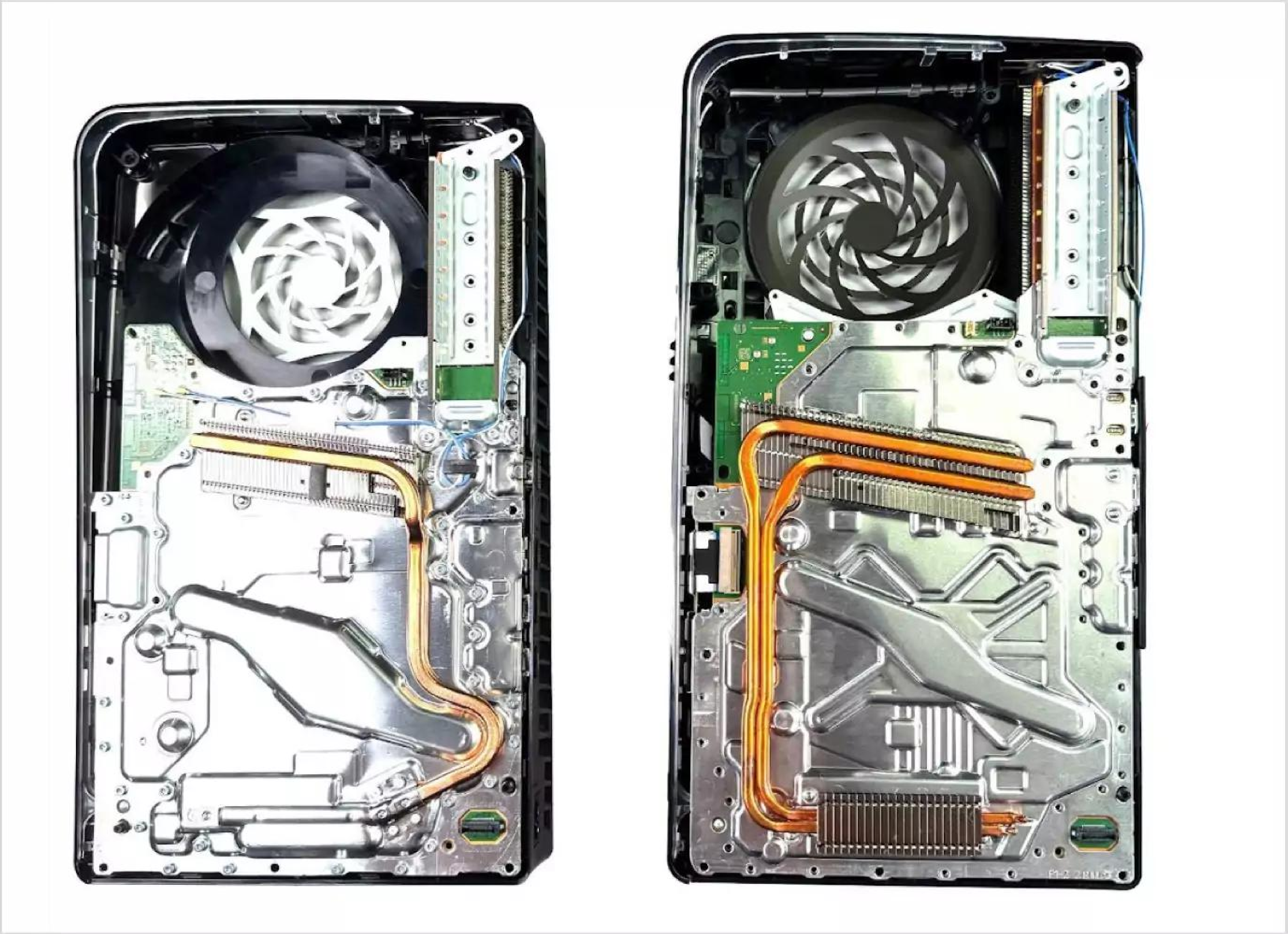
IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Sony PS5 Pro

We're glad to see those same easily removable panels in the PS5 Pro that let you get dust out of your fan, even if you can't find your screwdriver.

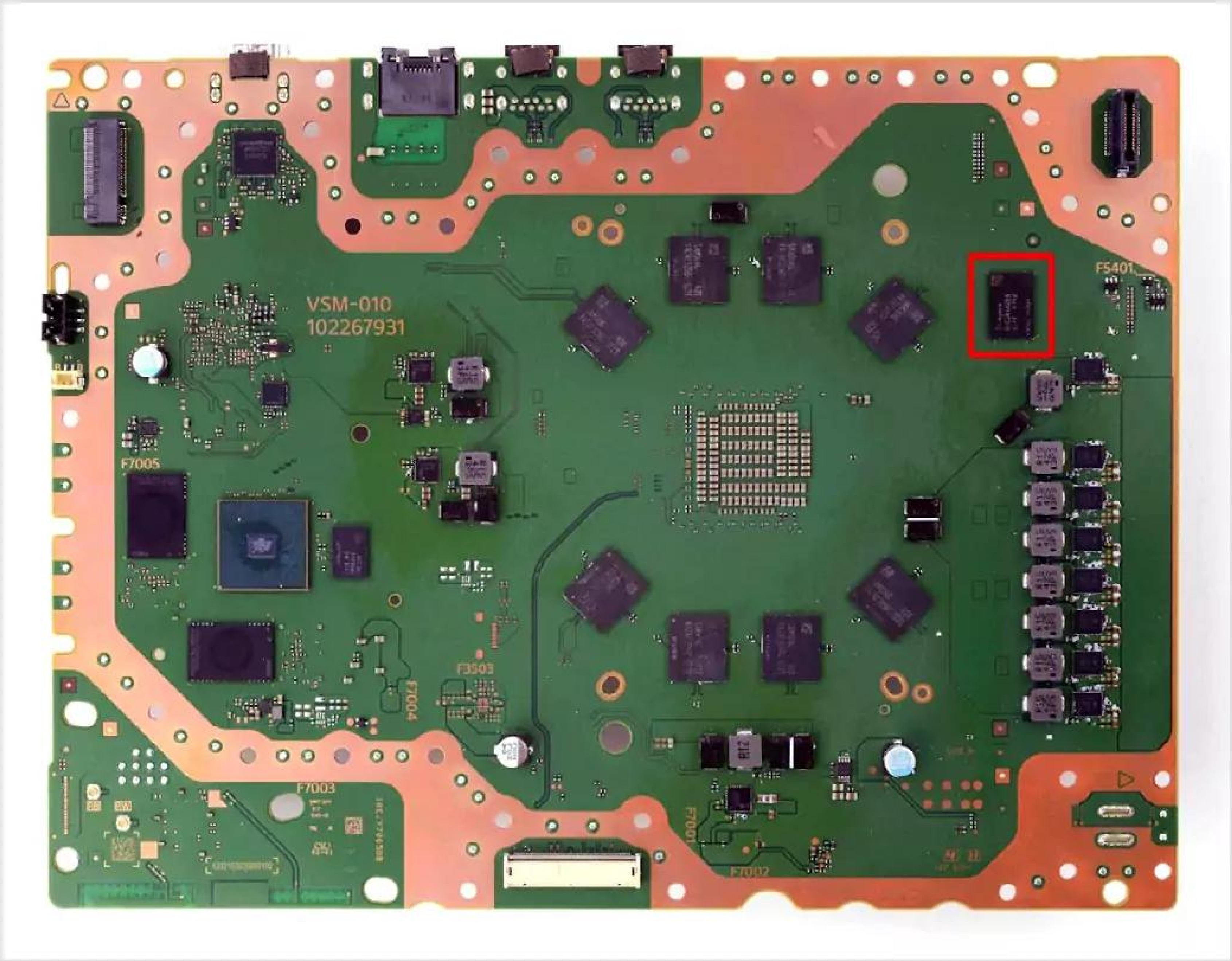


About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products.
To learn more, visit www.ifixit.com

© REPAIR TECHNIQUE PS5 PRO TEARDOWN

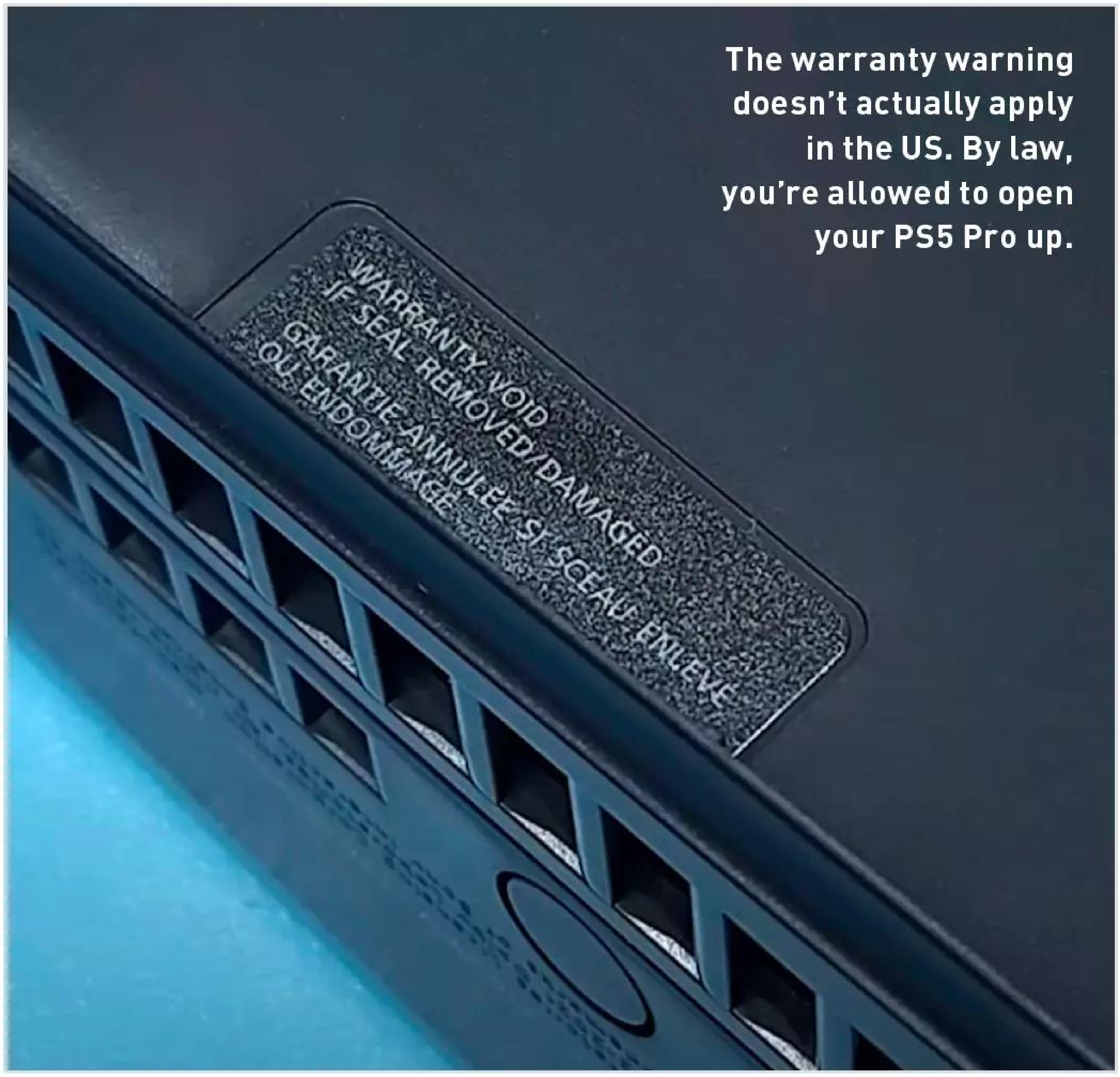
Sony's PS5 Pro is widely being billed as a generational upgrade to the pandemic-era PS5 and its progenitor, the PS5 Slim.



Above: An additional 2GB of DDR5 RAM dedicated to servicing the PS5 Pro's OS should free up the remaining 16GB of GDDR6 RAM for those demanding games.

Below far left: We're glad to see an easily replaceable CMOS battery, but that's the only change from the other PS5 models that's worth writing home about.

Below left: It's not the electronics that take up all that space, it's the thermal management system. Check out the new heat pipes on the PS5 Pro (right) PS5 Slim build (left).



The warranty warning doesn't actually apply in the US. By law, you're allowed to open your PS5 Pro up.

BACKGROUND

Sony's PS5 Pro has a new custom-made AMD processor on TSMC's 5nm node, and Sony promises 45 percent faster graphics performance versus the original PS5. But what other changes are there inside, and is this new console any easier to pull apart and repair?

MAJOR TECH SPECS

- 8-core, 16-thread AMD Zen 2 CPU
- 60 CU AMD RDNA 2 (with some RDNA 3 and 4 features) GPU, 16.7TFOPs
- 16GB GDDR6 memory, 256-bit memory bus, plus 2GB DDR5
- 2TB custom M.2 SSD, external storage via USB
- 1x HDMI 2.1, 1x Ethernet, 2x USB-C, 2x USB-A
- Wifi 7, Bluetooth 5.1
- 3.1kg (6.8lbs), 388 x 89 x 216mm

KEY FINDINGS

- The biggest repairability news in the PS5 Pro is that you can change the CMOS battery by removing a single screw. In previous PlayStation models, changing that battery was a pain. This is the second time recently that we're seeing an easily replaceable CMOS battery, the first being from our Mac mini teardown—a trend we can get behind!

- With the original PS5, Sony introduced an awesome tool-free panel removal design that lets you get dust out of your fan even if you couldn't find your screwdriver. We're glad to see those same easily removable panels in the PS5 Pro. If your console doubles as a cat bed, at some point you'll need to get the cat hair out of the fan. By removing just four screws and a JST-style connector, you can take the whole fan out for a deep clean when necessary.

- But that really is where any progress towards repairability ends on the PS5 Pro. Calling this an iterative improvement in design for repairability would be an understatement. Just take the tamperproof sticker at the bottom as an example. The international version of the PS5 Pro has 'WARRANTY VOID IF SEAL REMOVED/DAMAGED; over it. These stickers are actually unenforceable in the US, per the Magnuson-Moss Warranty Act—and if Sony tries to give you grief about opening up your console, you can report them to the FTC.

- With every chip, performance core, and teraflop of improvement also comes a headache for engineers on how to manage all the additional heat being produced. This is probably the biggest reason why any console needs to be as big as it is. It's not the electronics that take up all that space; it's the thermal management system.

- It's a conundrum that can only be fixed with better heat transfer materials. That means liquid metal, a material that markedly improves thermal transfer when compared to thermal paste. And that means more copper, more heat pipes, more fins, and more heatsinks. But copper is bulky, so why use it? Because it strikes a reasonable balance between thermal transfer properties and material cost. So it's the chunky console for you my lad or lass, and be happy about it too.

- Repairability Score: 6 out of 10 (10 is easiest to repair). In all, we're glad to see that the PS5 Pro has kept the best repair features of its predecessors—the toolless entry, easy-access fan, repeatable connectors on some important components. We're even happier to see Sony prioritizing CMOS batteries. Now, how about dropping those fear-mongering, anti-repair warranty stickers?.

Improve your memory with Windows Recall

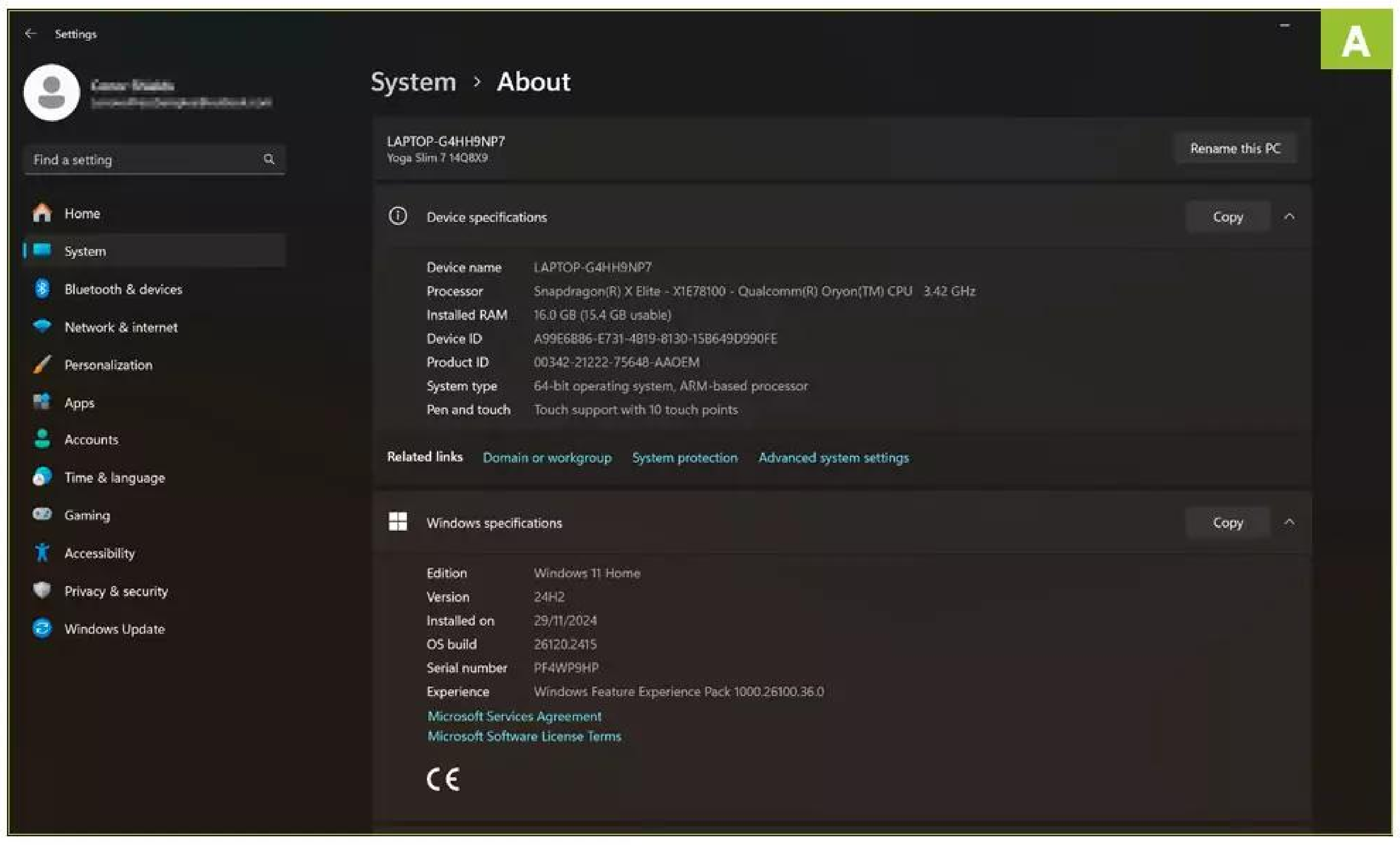
YOU'LL NEED THIS

A COPILOT+ PC
Nothing to hide

SINCE ITS ANNOUNCEMENT at Microsoft's Build conference in May 2024, Recall has had a torrid time. Not only has it been criticized as being a privacy-busting nightmare, but at the time of writing, it's restricted to the Snapdragon-powered Copilot+ PCs, of which there aren't many. It was removed from Windows 11's preview versions while Microsoft worked on it a bit more.

At the beginning of December, a Dev Channel version of Windows 11 24H2 appeared with Recall returned to its place in the System Tray. If you've managed to avoid all the Recall-based discourse, it's a system that takes constant snapshots of your PC's active app. These are literal, image-based snapshots; not the sort of snapshots associated with backup software. These are then stored, and AI is used to parse the text and images in them, which is catalogued, and you can then search within this catalog with natural-language text queries or by sliding back along a timeline to find something you were working on or searching for.

Problems with this are instantly visible. What about banking apps or other confidential information? Is the snapshot library encrypted? Can I turn this off? Does it have an effect on battery life? All good questions, and ones we'll do our best to address here. **–IAN EVENDEN**



System › About

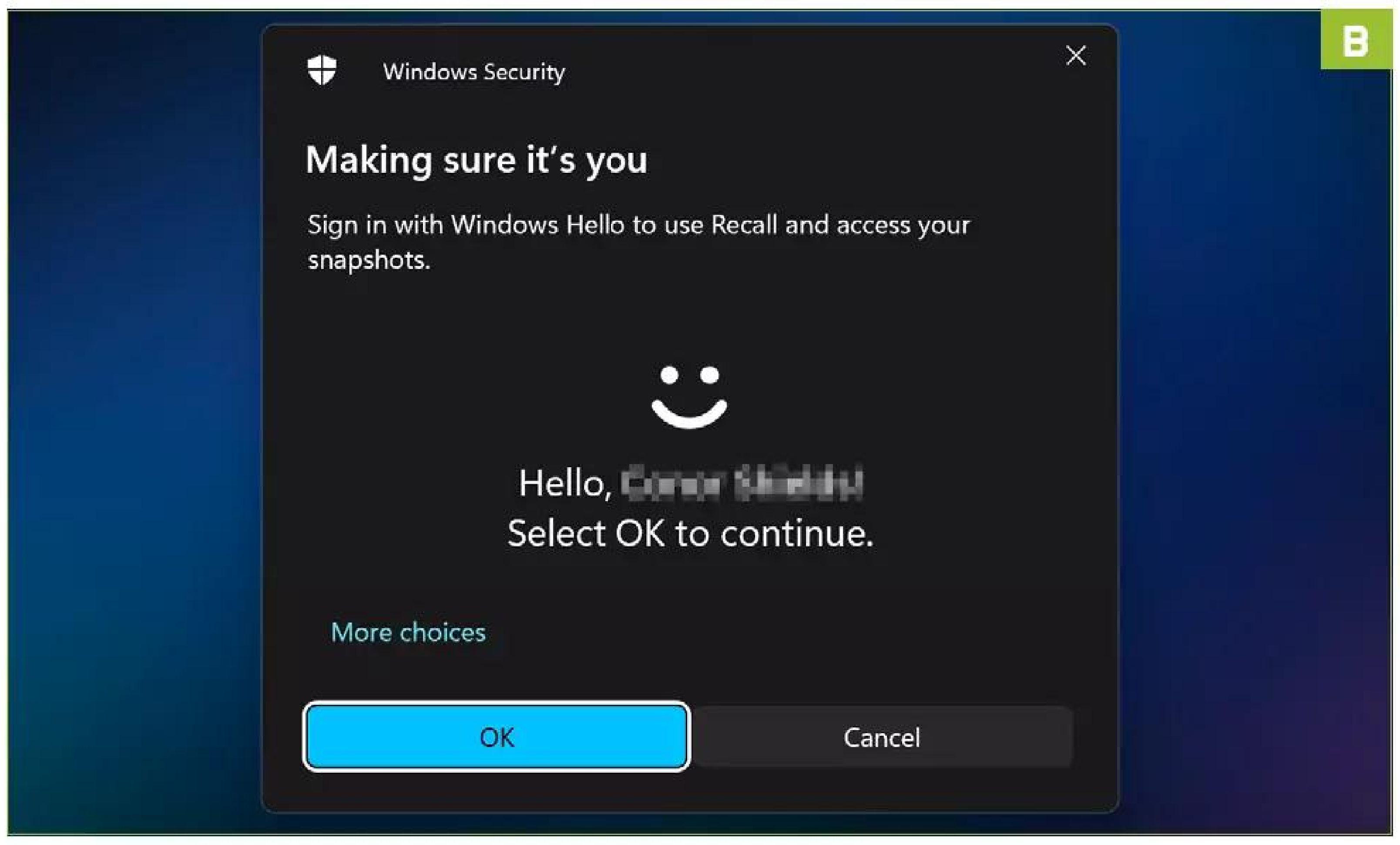
LAPTOP-G4HH9NP7
Yoga Slim 7 14Q8X9

Device specifications

Device name	LAPTOP-G4HH9NP7
Processor	Snapdragon(R) X Elite - X1E78100 - Qualcomm(R) Oryon(TM) CPU 3.42 GHz
Installed RAM	16.0 GB (15.4 GB usable)
Device ID	A99E6886-E731-4819-8130-15B649D990FE
Product ID	00342-21222-75648-AAOEM
System type	64-bit operating system, ARM-based processor
Pen and touch	Touch support with 10 touch points

Windows specifications

Edition	Windows 11 Home
Version	24H2
Installed on	29/11/2024
OS build	26120.2415
Serial number	PF4WP9HP
Experience	Windows Feature Experience Pack 1000.26100.36.0



Making sure it's you

Sign in with Windows Hello to use Recall and access your snapshots.

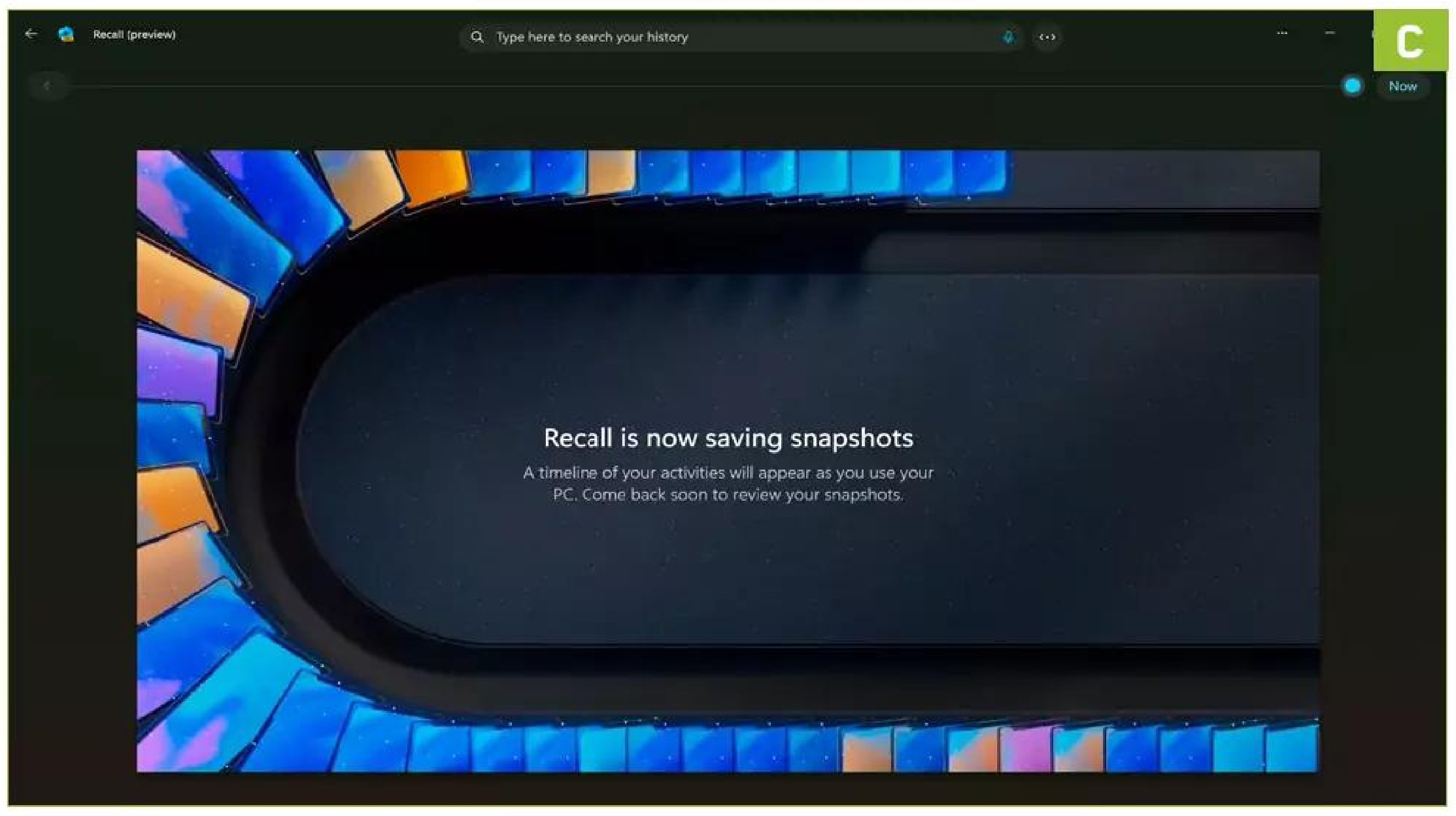
Hello, [redacted]
Select OK to continue.

1 TO THE DEV CHANNEL

If you've got a compatible Copilot+ PC, you'll probably have been waiting for Recall to partially justify your purchase. It's one of the features we were promised that a Copilot+ PC could do that older, less AI-filled machines could not, and its absence has been felt. Microsoft has stated that it will become available for x86 processors, too, though presumably only those with an NPU or enough of a GPU to run a machine learning model on. At the time of writing, you can install a Dev Channel build on your Copilot+ PC via Windows Update, as long as you're enrolled in the Windows Insider Program, with the build number 26120.2415 [**Image A**] or later. It's worth noting that Dev Channel builds can come with some rough edges and low stability. They're not as bad as those in the Canary Channel, but also not as polished as the Release Preview Channel. We've had no problems with this particular Dev build running on a Lenovo Yoga PC with a Snapdragon X Elite processor and 16GB of RAM, but all combinations of hardware and software are different, and you may encounter problems. If your PC is essential to your work, it's probably not worth the risk, and you should wait for a more stable build, or even the final release.

2 PRIVACY CONCERNS

Once you've got the build installed and booted up, you'll find Recall in the System Tray. Its icon looks like the Copilot one, though a bit less brightly colored. Microsoft has tweaked the way it works to address privacy concerns. It can now be switched off or removed from the PC completely, and it requires a logged-in Microsoft account with Windows Hello switched on [**Image B**] in order to access the timeline. These security precautions will go some way toward calming the fears of those who see it as an intrusive system that can be used by criminals or other bad actors to grab confidential information, as is the way Recall itself ignores private browsing windows, and can be told not to gather data from specific apps.

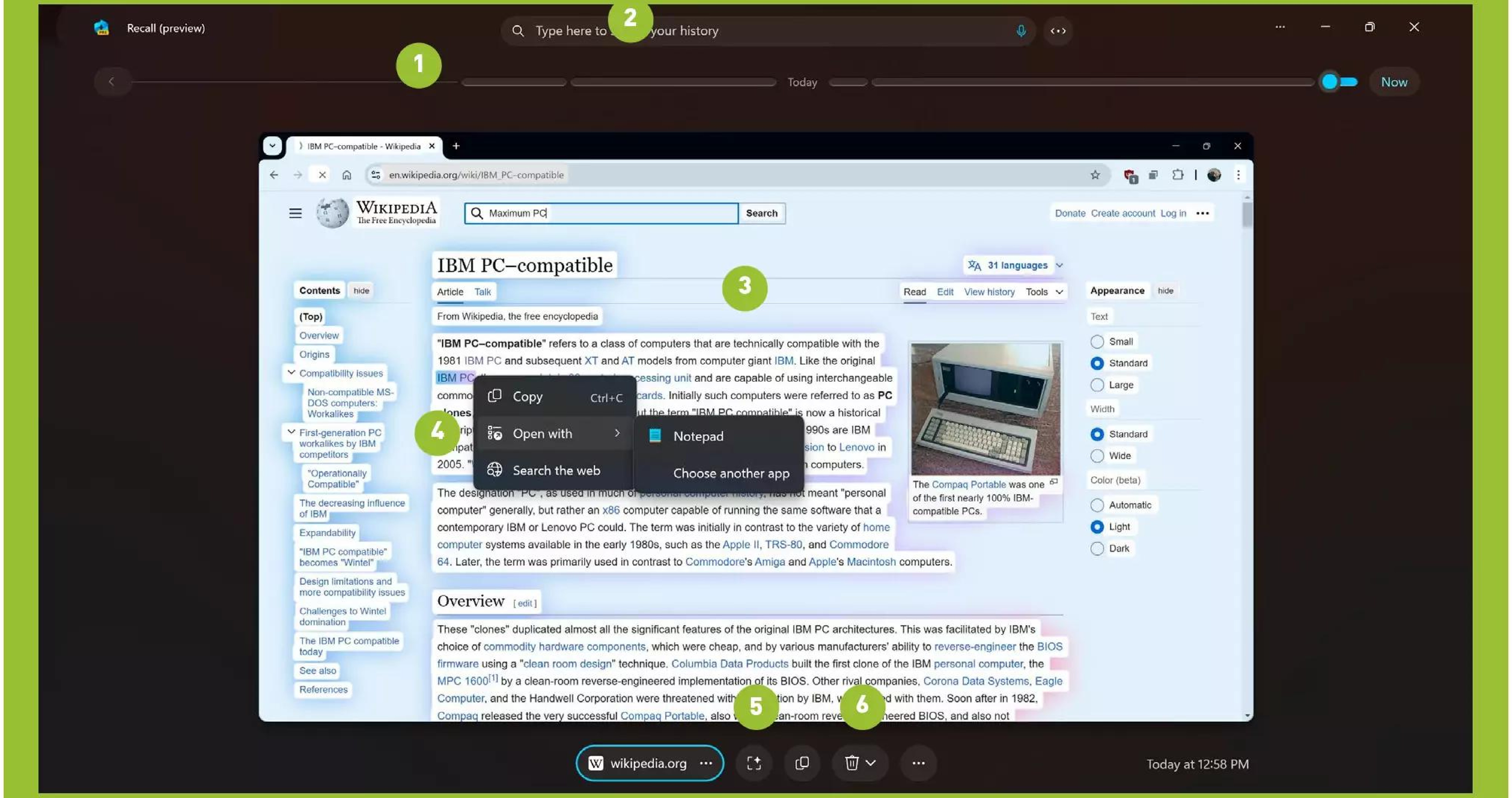


Recall is now saving snapshots

A timeline of your activities will appear as you use your PC. Come back soon to review your snapshots.

© MICROSOFT

INSIDE THE INTERFACE


Recall (preview)
Type here to search your history
1
2
Today
Now
IBM PC-compatible - Wikipedia
en.wikipedia.org/wiki/IBM_PC-compatible
Wikipedia
The Free Encyclopedia
Maximum PC
Search
Donate Create account Log in
Contents hide
(Top)
Overview
Origins
Compatibility issues
Non-compatible MS-DOS computers: Workalikes
First-generation PC workalikes by IBM competitors
"Operationally Compatible"
The decreasing influence of IBM
Expandability
"IBM PC compatible" becomes "Wintel"
Design limitations and more compatibility issues
Challenges to Wintel domination
The IBM PC compatible today
See also
References
31 languages
Article Talk
Read Edit View history Tools
Appearance hide
Text
○ Small
● Standard
○ Large
Width
● Standard
○ Wide
Color (beta)
○ Automatic
● Light
○ Dark
3
4
Copy Ctrl+C
Open with
Search the web
Notepad
Choose another app
5
6
wikipedia.org
Today at 12:58 PM

IBM PC–compatible

From Wikipedia, the free encyclopedia

"**IBM PC–compatible**" refers to a class of computers that are technically compatible with the 1981 IBM PC and subsequent XT and AT models from computer giant IBM. Like the original IBM PC
cessing unit and are capable of using interchangeable
commo
cards. Initially such computers were referred to as **PC**
clones
ut the term "IBM PC compatible" is now a historical
descrip
990s are IBM
compat
sion to Lenovo in
2005. "
computers.

The designation "PC", as used in much of personal computer history, has not meant "personal computer" generally, but rather an x86 computer capable of running the same software that a contemporary IBM or Lenovo PC could. The term was initially in contrast to the variety of home computer systems available in the early 1980s, such as the Apple II, TRS-80, and Commodore 64. Later, the term was primarily used in contrast to Commodore's Amiga and Apple's Macintosh computers.

The Compaq Portable was one of the first nearly 100% IBM-compatible PCs.

Overview [edit]

These "clones" duplicated almost all the significant features of the original IBM PC architectures. This was facilitated by IBM's choice of commodity hardware components, which were cheap, and by various manufacturers' ability to reverse-engineer the BIOS firmware using a "clean room design" technique. Columbia Data Products built the first clone of the IBM personal computer, the MPC 1600[1] by a clean-room reverse-engineered implementation of its BIOS. Other rival companies, Corona Data Systems, Eagle Computer, and the Handwell Corporation were threatened with
tion by IBM, w
d with them. Soon after in 1982, Compaq released the very successful Compaq Portable, also w
an-room reve
neered BIOS, and also not

1. TIMELINE
This is divided into sections that reflect the time you've been using your PC. You can scrub back and forth like a video to reveal snapshots.

2. SEARCH
Either type in simple search terms or natural language queries like 'website I visited yesterday afternoon' to get a grid of results.

3. SNAPSHOT
Each snapshot is a screenshot of your PC's display, broken up into apps and sections, depending on their content.

4. CONTEXT MENU
A simple right-click gets you a menu to copy text or open in another app. This will be added to as Phi Silica rolls out.

5. CLICK TO DO
Use this button to turn Click To Do on and off. Recall is most useful with it switched on, as without it, all you can do is view the screenshots.

6. COPY, DELETE, OPEN
Delete the snapshot, delete all snapshots from that app, copy the snapshot to the clipboard, or open it in the Snipping Tool from here.

3 GET STARTED

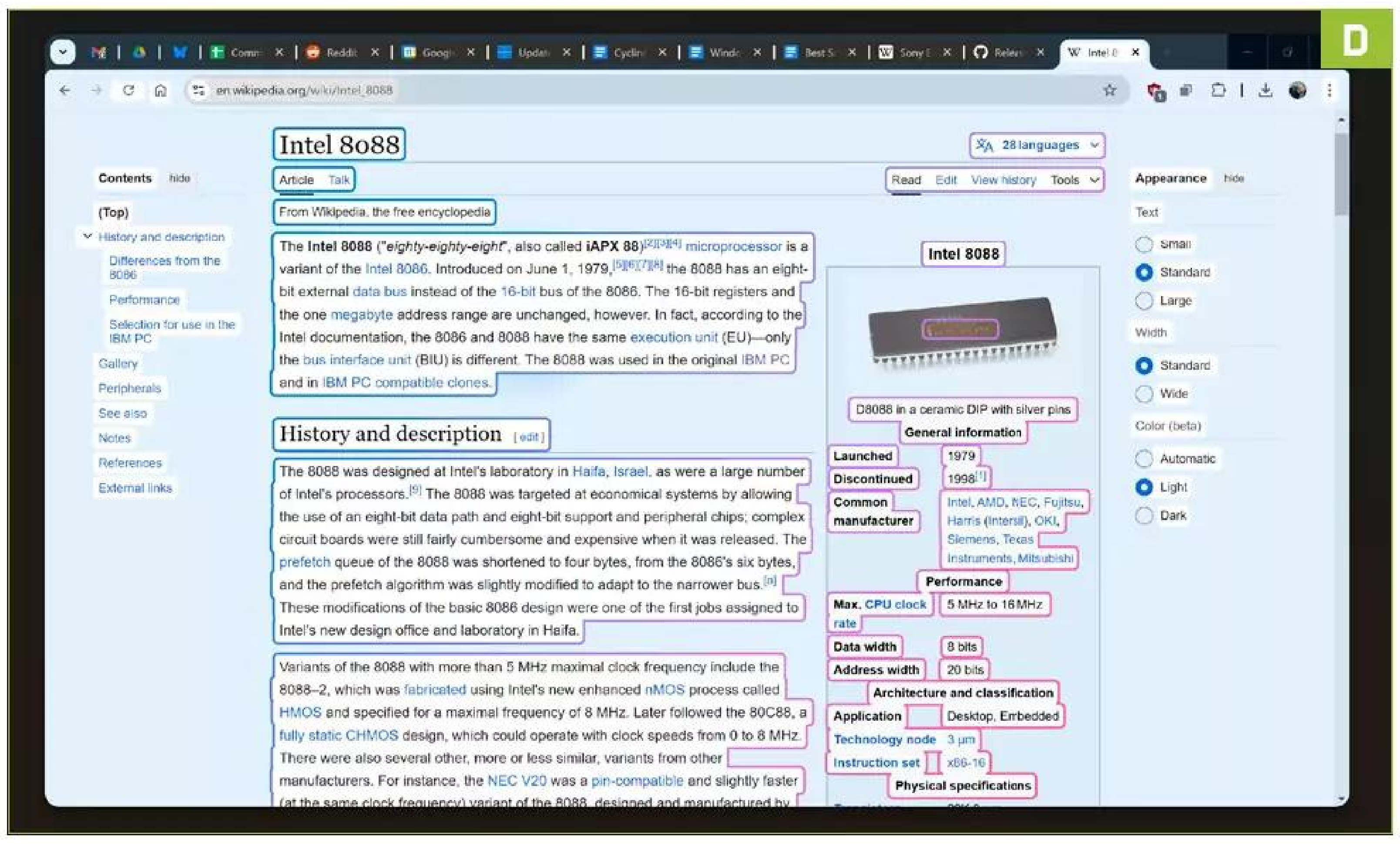
Recall won't start capturing its snapshots if you're not logged in. To begin, pop up the Recall window from its System Tray icon, and log in. Once it's happy that you are who you say you are, you'll get confirmation that it's working [Image C]. From then on, feel free to ignore it for a bit. It needs time to take its snapshots and build up its database. Microsoft Support says Recall takes a screenshot "every few seconds", so it may miss things that are only fleetingly on your screen, and is therefore not infallible.

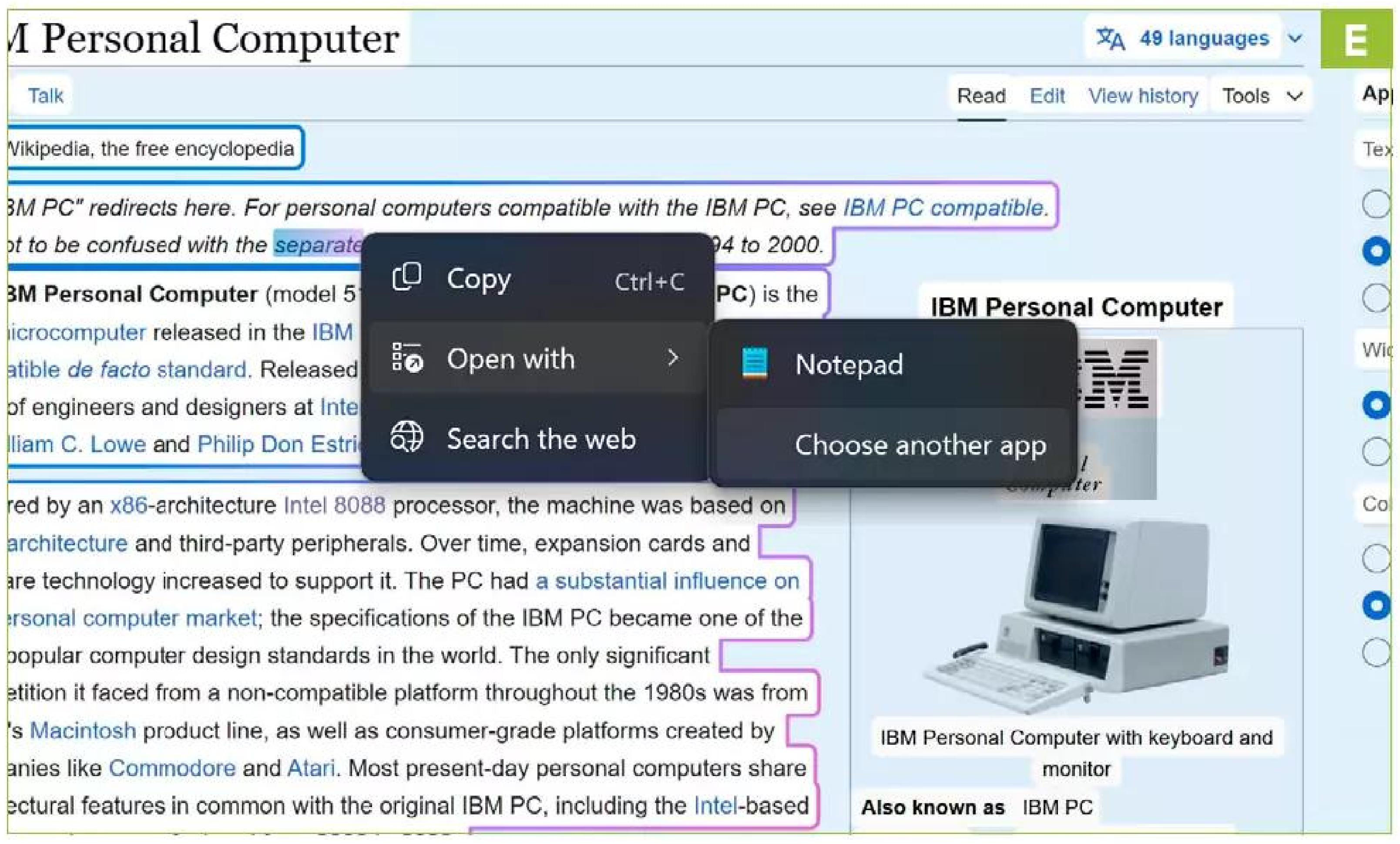
4 GO BACK IN TIME

Once you've left it running for a bit, you'll be able to use the Recall icon, or the Win-J keyboard shortcut, to open the main Recall window. You'll have to authenticate again to get any further, so make sure you're facing the camera. Once in, you'll see the most recent snapshot taken, along with a timeline at the top of the interface [Image D]. From here, you're able to scrub along the timeline to return to a snapshot of something you were looking at earlier, or use the forward and back buttons at the sides of the screenshot window. As they're just raster screenshots, you're not actually able to dive into them and continue where you left off, but Recall turns images and lines of text within the snapshots into hotspots that you can click on to copy or web search with. You can even save the screenshot itself out of Recall to a folder on your PC, via the Snipping Tool, if that's useful to you.

5 COPY AND SEARCH

Once a snapshot has been processed by your PC's NPU, it will highlight blocks of text or images as you pass the mouse pointer over them. Recall doesn't use your system pointer style, instead using a large round one of its own, with a colored shadow under it. It doesn't show up well in screenshots, and once you pass it over something it can interact with, it changes to a thinner cursor that you can use for selecting text. Any lettering within the snapshots becomes selectable [Image E], and if you right-click on it, you get the choice to copy it, open it in Notepad (the default) or any other apps you add to the list, or use it as the basis of a web search. Unlike other Microsoft apps, such as Windows Spotlight Wallpaper, it opens your default browser to do this, rather than forcing you into Edge.




E
Personal Computer
49 languages
Talk
Read
Edit
View history
Tools
Copy
Ctrl+C
Open with
Search the web
Notepad
Choose another app
IBM Personal Computer
IBM Personal Computer with keyboard and monitor
Also known as
IBM PC

6 WORK WITH IMAGES

Right-click on an image that Recall has identified in a snapshot (it's not infallible at this, preferring to recognize any text within the images rather than the images themselves), and you'll get a longer menu [**Image F**]. You can save the image from within the snapshot, but what you really get is a square crop that includes the image. You can also open this in Paint, Photos, or another app you've set up. You can copy the image to paste into a document, or share it from the standard Windows sharing interface. You can also do a reverse image search on the web using the extracted image, but this has to be done with Bing.

7 SEARCH

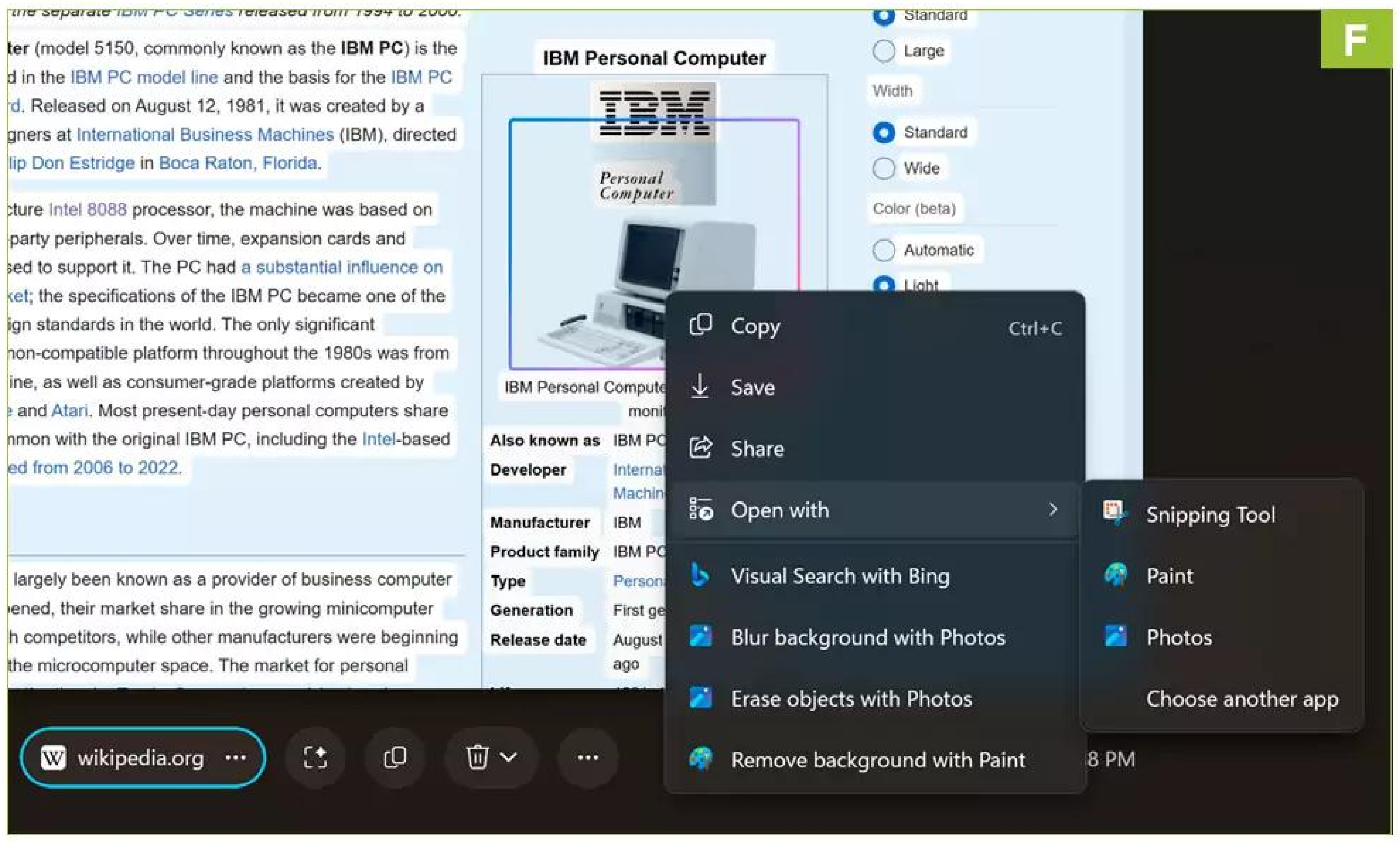
At the top of the Recall window is a search box. In this, you can type queries in natural language, as well as hunting for specific text strings. So "that document about laptops I was working on yesterday" will bring up results, as will "kitchen mixer" or "kittens", depending on what you recall looking at. This can be useful if you want to remind yourself of something you half-remember seeing, but in many ways, it's a clever version of your internet history with a nice graphical front-end on it. The results page brings up text and image hits for your search term, along with the ability to filter by app, and a disclaimer at the bottom that AI can sometimes get things wrong. It is surprisingly fast, at least with our snapshot database of only a few days, and neatly categorized. Click on a result, and you're taken to the snapshot containing it, with the relevant part highlighted.

8 CLICK TO DO

The overlay that appears on top of your Recall snapshots and powers all this text and image recognition is called Click To Do, and the basics are included with any PC that can run Recall. There is a way to improve its capabilities, including adding text summarizing and rewriting, via the Phi Silica small language model. This differs from the large language models you've probably already heard of by being, well, smaller. Rather than running in the cloud in a data center somewhere, it can execute on the NPU in your Copilot+ PC. According to Microsoft, all you need to do is have your PC's default language set to English, but we didn't see any evidence of it being available, or any way of installing it, until we were halfway through writing this tutorial, when Windows Update fired into life and downloaded both Phi Silica and some new image extraction algorithms. Even with the SLM installed, it didn't appear in Recall, which goes to show that this is new technology in a state of constant improvement. By the time you read this, some extra features may have been patched in.

9 IN OTHER APPS

Click To Do is also available in apps outside of Recall. You can find it in the Search results box, and in the Snipping Tool via a button at the top of the interface called Text actions. It can isolate the text in a screenshot you want to share, and either copy it out or


F
IBM Personal Computer
Copy
Ctrl+C
Save
Share
Open with
Visual Search with Bing
Blur background with Photos
Erase objects with Photos
Remove background with Paint
Snipping Tool
Paint
Photos
Choose another app
wikipedia.org

KEYBOARD SHORTCUTS

Aside from Win-J to open Recall and Win-Q for the Click To Do toolbar, there are a few other keyboard shortcuts that can make navigating the Recall window a smoother process. Once you're in the app window, Home and End will take you to the beginning and end of the snapshot timeline, while Tab moves you through the sections it creates for different periods of computer use, with Shift-Tab moving you back. Ctrl-left and right arrow keys will drag the timeline indicator to the left and right, while Enter will take you to the first snapshot in the section you're in.

In Click To Do, Enter will move you through the different elements the system has detected in the snapshot you're interacting with; Tab moves you to the next parent element, and Esc takes you back up a level. The arrow keys move you around the snapshot's elements, while Ctrl-left/right moves you between words in a text group. Ctrl-Shift-left or right selects words one by one, and can remove them from a selection if you reverse direction. The space bar opens the context menu for a selected item. Alternatively, you can use the mouse to do all these things.

© MICROSOFT

redact it with a big black line. Press Win-Q, and you can open a Click To Do toolbar in any app, which immediately recognizes any text on the screen, whether it's editable or within an image, and allows you to search or copy it. The tech has also been added to Microsoft's AI API, so it can be invoked from within apps developed with Copilot+ PCs in mind, and soon won't be confined to Recall. We suspect we'll see a lot more of it as NPUs spread out through the PC-using sphere, with the ability to search within images being particularly handy.

10

SETTINGS

All this AI is going to require some setting up, and there's a new section in the Settings app's Privacy & Security section under Windows Permissions. Named Recall & Snapshots [**Image G**], it's linked to from within the Recall app itself and contains options for excluding apps and websites from the all-seeing AI, as well as limiting how much room its screenshot cache takes up. Recall snapshots and associated data are processed locally by Windows device in a secure area called a Virtualization-based Security Enclave, using the TPU module Microsoft forced you to have in order to get Windows 11 in the first place, so your data shouldn't leave your device and end up in the cloud. You can also delete the snapshots from the settings page, either by choosing a date range to purge or nuking the lot. You can also see how much storage it's using, and set an upper limit, after which the oldest screenshots will be deleted.

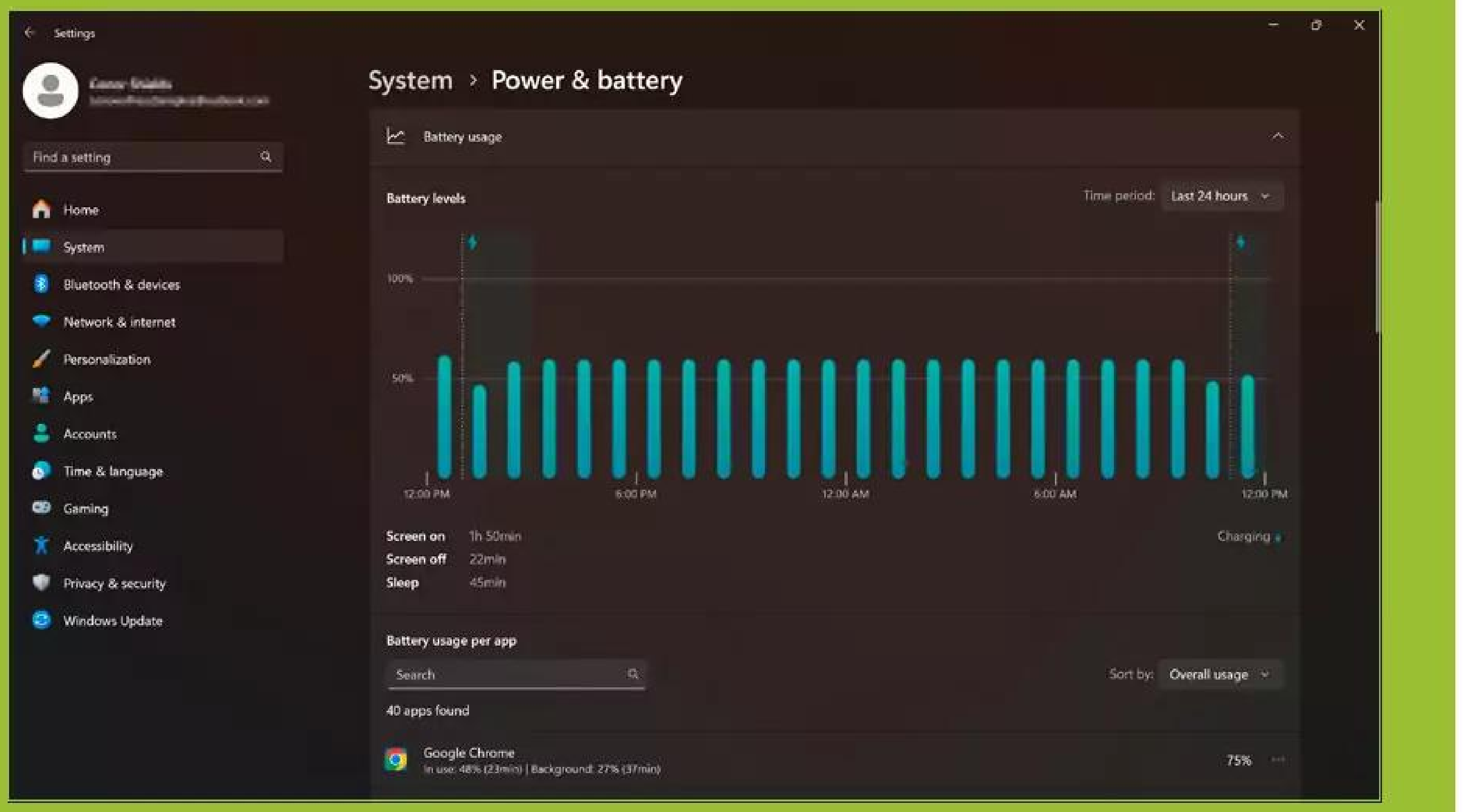
11

ADD FILTERS

From the Settings page, you can also add filters so that particular apps and websites are ignored and not included in snapshots. Recall already ignores private browsing windows from supported browsers—we tested this with Chrome, and Microsoft says Opera, Firefox, and, of course, Edge, are supported. All Chromium-based browsers should be able to hide from Recall, but if you're using something more unusual, you'll need to test it out before you access information you don't want recorded. There's also a switch in the settings for it to recognize and ignore sensitive information such as passwords, which is on by default. It's worth opening up the Websites to Filter section and adding in the URL of your bank or anything else that's financial or just private—all you need to do is add a valid URL into the box that appears after you click the Add Website button.

» It's also possible to filter apps out of Recall's panopticon, and pressing the Add App button brings up a searchable list of the apps installed on the PC, similar to the Open With window that can be reached by right-clicking on a file [**Image H**]. You can tell if Recall is being filtered, as the icon in the System Tray changes: a filtered window brings up a T-shaped addition to the icon, which remains blue, while if Recall is completely paused (which can be done from the menu that appears if you click on its icon), it turns white and has a line through it. If Recall cannot start—which often means that you need to sign in with Windows Hello—it turns yellow. You'll need to sign in every time it starts or opens.

BATTERY LIFE


Settings
[redacted]
Find a setting
Home
System
Bluetooth & devices
Network & internet
Personalization
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
100%
50%
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM

System › Power & battery

Battery usage

Battery levels

Time period: Last 24 hours

Screen on 1h 50min
Screen off 22min
Sleep 45min

Charging

Battery usage per app

Search

Sort by: Overall usage

40 apps found

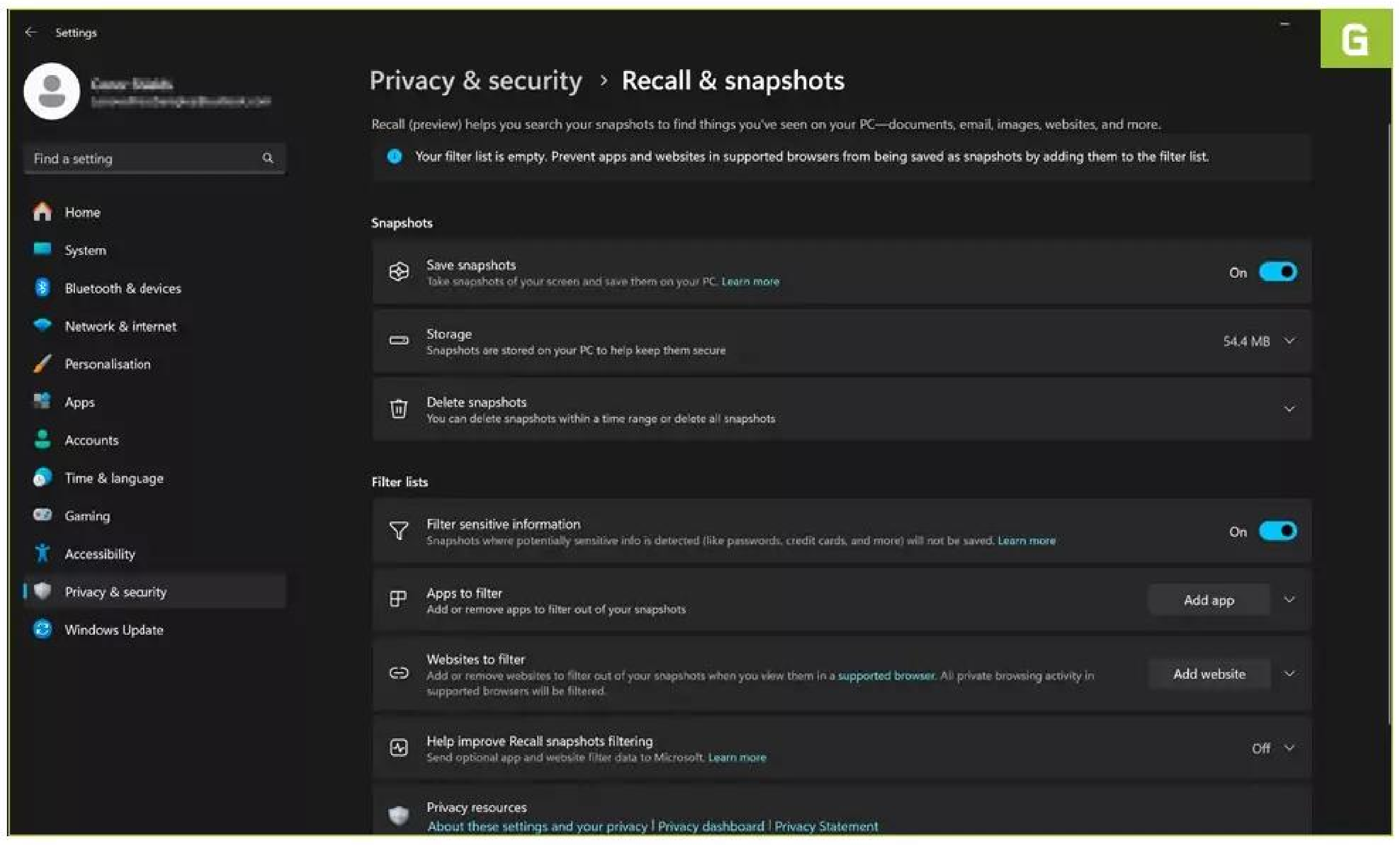
Google Chrome — In use: 48% (23min) | Background: 27% (37min) — 75%

If there's one thing AI is known for, it's energy use, notably the environmental impact of AI in data centers. A recent study published by researchers at AI company Hugging Face found that generative AI can eat up in the region of 33 times more energy than machines running task-specific software. In your PC, the constant use of the NPU for Recall and Click To Do will use more battery power than if it was sitting idle, and we definitely noticed a lower battery life in our test laptop. As one of the great selling points of an ARM-based Copilot+ laptop is the extended battery endurance (almost 12 hours from a charge, in the case of the Lenovo we were using), having something that brings it back to X86 levels of runtime negates this. Recall didn't appear on the list of apps using significant power, though. Chrome was at the top, but second was the Windows Experience Feature Pack, which may be where Recall is housed. Being able to extend your PC's battery life therefore becomes one of the best reasons for uninstalling Recall, especially if you find you don't use it.

12

TURNING IT OFF

Now that we've seen how to use Recall, here's how to *not* use it. The easiest way is to go to its Settings page and switch off Save Snapshots. This disables it, but leaves it on your PC. If you want to remove it, open the Turn Windows Features On or Off page in the Control Panel, and untick it. There are no sub-folders in the Recall entry—it's on or off, all or nothing. ⏻


G
Settings
[redacted]
Find a setting
Home
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update

Privacy & security › Recall & snapshots

Recall (preview) helps you search your snapshots to find things you've seen on your PC—documents, email, images, websites, and more.

Your filter list is empty. Prevent apps and websites in supported browsers from being saved as snapshots by adding them to the filter list.

Snapshots

Save snapshots — Take snapshots of your screen and save them on your PC. Learn more — On

Storage — Snapshots are stored on your PC to help keep them secure — 54.4 MB

Delete snapshots — You can delete snapshots within a time range or delete all snapshots

Filter lists

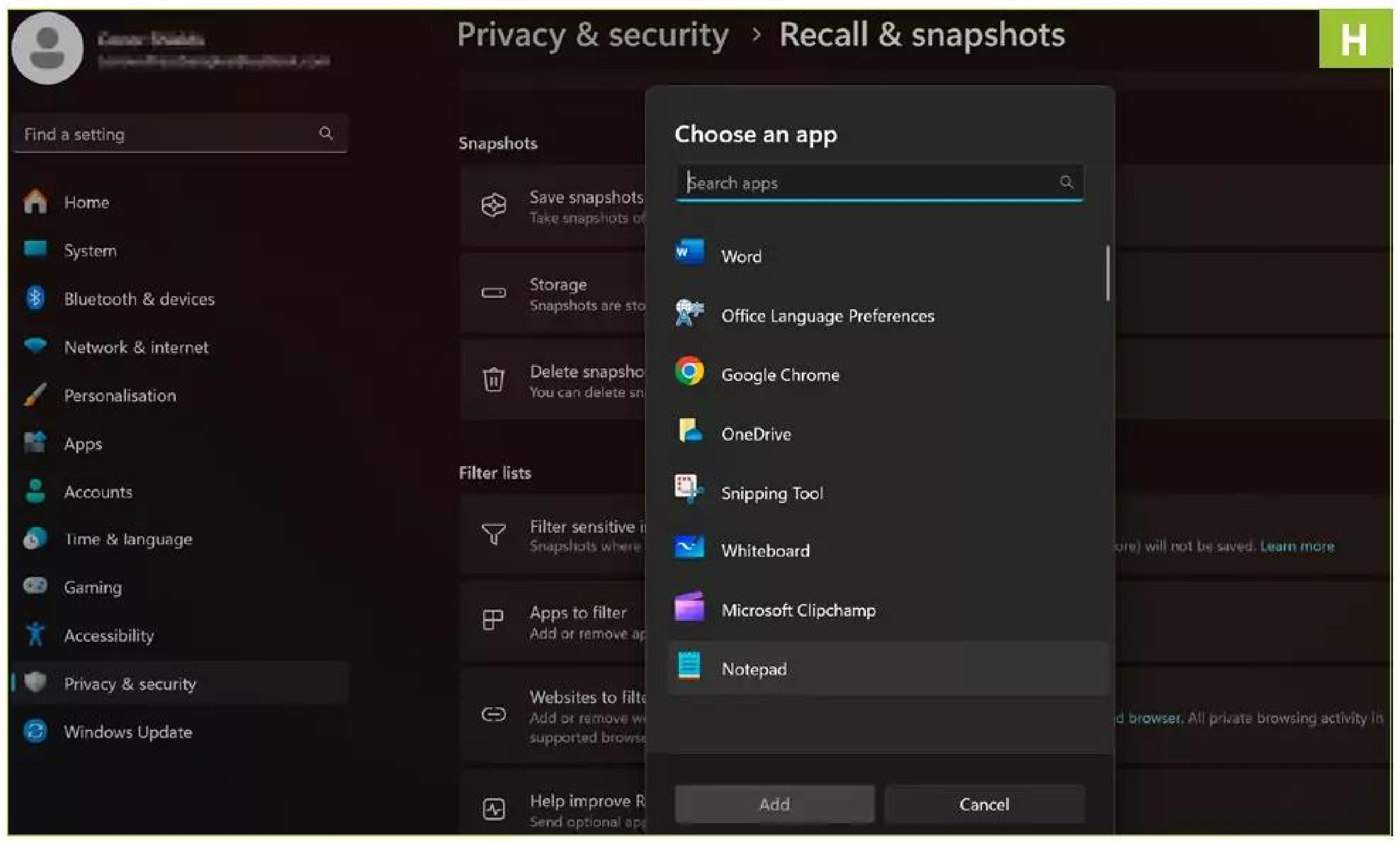
Filter sensitive information — Snapshots where potentially sensitive info is detected (like passwords, credit cards, and more) will not be saved. Learn more — On

Apps to filter — Add or remove apps to filter out of your snapshots — Add app

Websites to filter — Add or remove websites to filter out of your snapshots when you view them in a supported browser. All private browsing activity in supported browsers will be filtered. — Add website

Help improve Recall snapshots filtering — Send optional app and website filter data to Microsoft. Learn more — Off

Privacy resources — About these settings and your privacy | Privacy dashboard | Privacy Statement


H
[redacted]
Find a setting
Home
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
Snapshots
Save snapshots
Storage
Delete snapsho
Filter lists
Filter sensitive i
Apps to filter
Websites to filte
Help improve R
Add
Cancel

Privacy & security › Recall & snapshots

Choose an app

Search apps

- Word
- Office Language Preferences
- Google Chrome
- OneDrive
- Snipping Tool
- Whiteboard
- Microsoft Clipchamp
- Notepad

Create your offline data vault

YOU'LL NEED THIS

A STABLE INTERNET CONNECTION
Docker (optional)
External drive (optional)

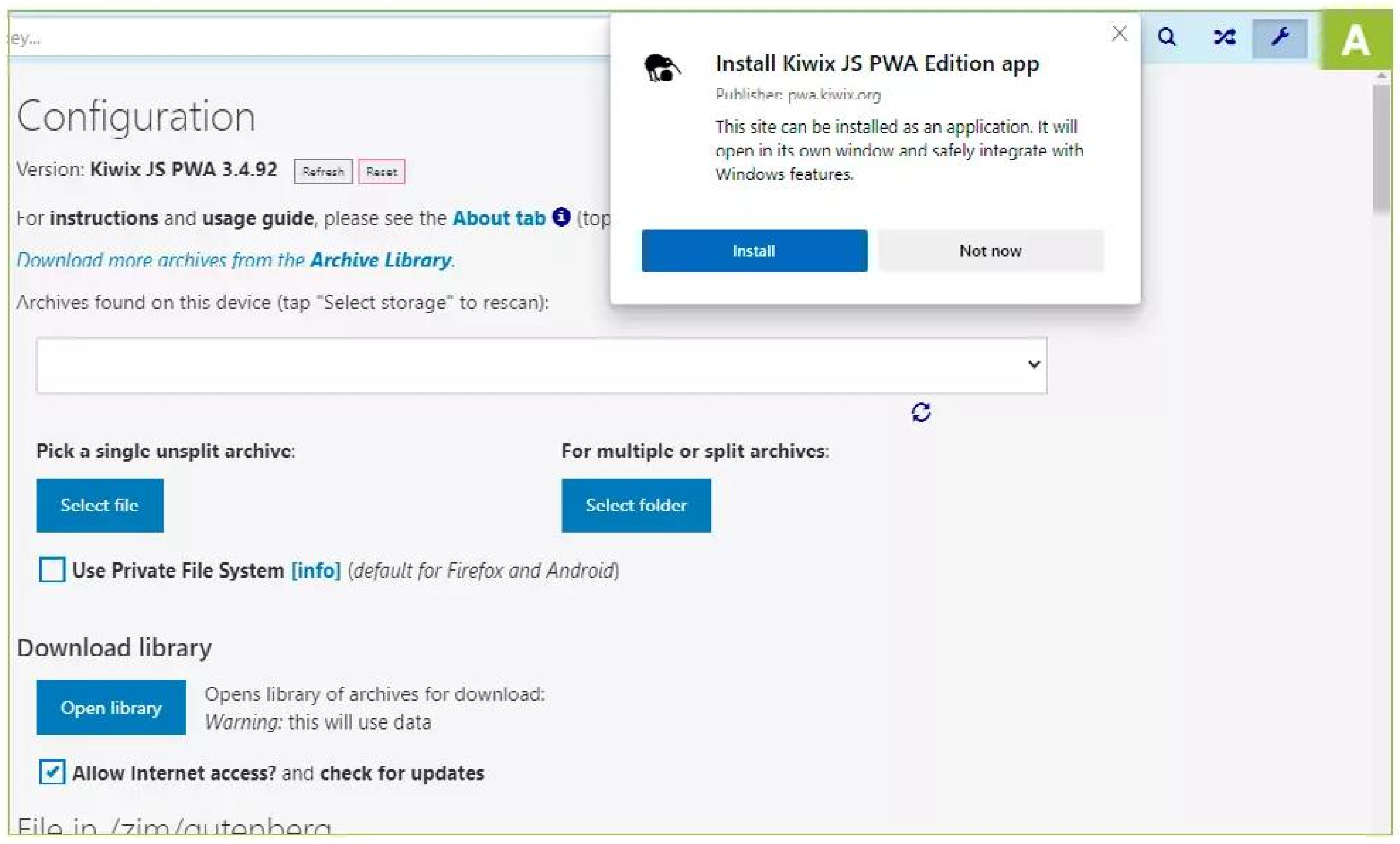
IN MAX BROOKS' EPIC ZOMBIE apocalyptic horror novel, *World War Z*, the fictional author interviews a representative of 'Radio Free Earth'. This was an initiative to transmit vital information to isolated communities, such as how to grow food, build shelters, and purify water.

US residents caught in the wake of Hurricane Helene in September 2024 will also remember how Starlink had to set up internet hotspots due to telephone lines being down. Fortunately, this was just temporary, but in the event of a prolonged outage, it's good to know that you have vital information at your fingertips.

This is where Kiwix comes in. It supports creating copies of public domain websites like Wikipedia, Project Gutenberg, and TED Talks for offline viewing. It uses the open ZIM (Zeno Improved) file format for downloading information, all accessible from a browser-like interface.

Even if you're not a survivalist, Kiwix is useful for people in locations with unreliable internet. You need a stable connection to download the ZIM files, but as the files and the Kiwix software is portable, you can easily download them to an external drive, then mail it wherever it's needed.

In this guide, you'll discover how to set up Kiwix, add archives, and share your post-apocalyptic vault with others. **–NATE DRAKE**



Install Kiwix JS PWA Edition app

Publisher: pwa.kiwix.org

This site can be installed as an application. It will open in its own window and safely integrate with Windows features.

Configuration

Version: Kiwix JS PWA 3.4.92

For **instructions** and **usage guide**, please see the **About tab** (top

*Download more archives from the **Archive Library**.*

Archives found on this device (tap "Select storage" to rescan):

Pick a single unsplit archive:

For multiple or split archives:

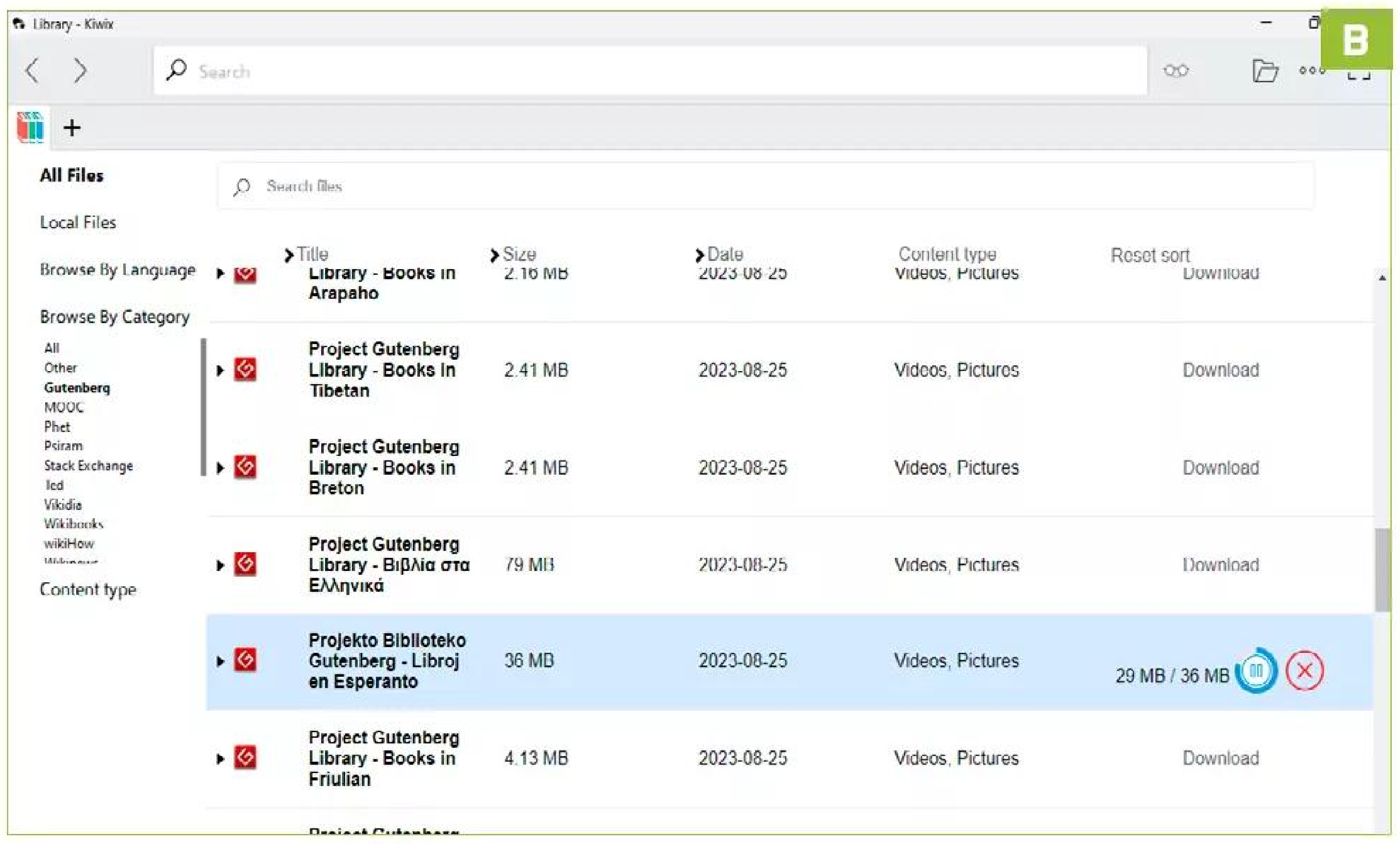
☐ **Use Private File System [info]** *(default for Firefox and Android)*

Download library

Opens library of archives for download:
Warning: this will use data

☑ **Allow Internet access?** and **check for updates**

File in /zim/gutenberg



Title	Size	Date	Content type	Reset sort
Library - Books in Arapaho	2.16 MB	2023-08-25	Videos, Pictures	Download
Project Gutenberg Library - Books in Tibetan	2.41 MB	2023-08-25	Videos, Pictures	Download
Project Gutenberg Library - Books in Breton	2.41 MB	2023-08-25	Videos, Pictures	Download
Project Gutenberg Library - Βιβλία στα Ελληνικά	79 MB	2023-08-25	Videos, Pictures	Download
Projekto Biblioteko Gutenberg - Libroj en Esperanto	36 MB	2023-08-25	Videos, Pictures	29 MB / 36 MB
Project Gutenberg Library - Books in Friulian	4.13 MB	2023-08-25	Videos, Pictures	Download

1 SET UP KIWIX (WINDOWS)

As *Maximum PC* readers are advanced users, we're aware that you don't need your hand held when it comes to downloading and launching installers.

» However, Kiwix offers several setup options. To see your choices, head to www.kiwix.org on the machine you plan to use for your vault, then choose 'Downloads' > 'All Apps'. As you'll see, there are native Kiwix applications for virtually every platform.

» Change the 'All Applications' drop-down menu to 'Windows'. If your machine is running Windows 10 or 11 then we recommend simply downloading the standard Kiwix 2.0. This is in the form of a compressed 'ZIP' archive, which can run from any location. This is useful if you want to store your vault data files on an external drive, as you can place Kiwix there, too.

» Once the download is complete, move the ZIP archive to your desired location. Next, extract it and run 'vc_redist.x64.exe'. This will install the latest Visual C++ Redistributable for Visual Studio 2015 from Microsoft, which is necessary to run Kiwix. Launch the app itself by running 'kiwix-desktop.exe'.

» According to the developers, you'll get the best performance from 'native' versions of Kiwix like this. However, you can also install Kiwix JS. This is written entirely in JavaScript, so is compatible with virtually every web browser. It's available as a browser extension for Edge, Chrome, and Firefox. **[Image A]**

» You can also install it as a PWA (Progressive Web App) directly from the Kiwix website. Simply click the relevant option, then choose 'Install PWA' at the top right of the browser window to load it as a standalone application. The 'Electron' version serves as a wraparound for the WPA and is designed for older versions of Windows.

» There's also a Universal Windows Platform (UWP) version of Kiwix available for WIndows tablets in the Microsoft Store. We don't recommend this, as the UWP format is no longer actively maintained.

2 ADD YOUR ARCHIVES (STANDARD VERSION)

If you chose to install the standard Windows version of Kiwix, you'll now be greeted with a blank page. Click the options button to choose 'Settings'. From here, you'll see that the default download folder for Kiwix's ZIM archive files is in AppData, eg. C:\nate\AppData\Roaming\kiwix. Click 'Browse' if you want to change this to a folder on an external drive. **[Image B]**

» Close Settings when you're done, and take a look at the left-hand pane. First, choose 'Browse by Language' if you want to filter content based on those you speak. Polyglots will be sad to learn that you can only choose one language at a time, but there's also an option for 'All'.

© KIWIX, KIWIX/PROJECT GUTENBERG

» Next, click on 'Browse by category'. This lists all the public domain sources that are available by default in Kiwix, such as Wikipedia and Project Gutenberg. In our tests, these initially took a minute or so to load, so you may have to be patient.

» Once the category does load in the main window, scroll down to the resource of your choice, and choose 'Download'. A download meter will mark the archive progress. Bear in mind that the archives vary in size. For instance, Project Gutenberg's entire eBook collection in English is over 71GB. By contrast, Gutenberg's Esperanto eBooks amount to only 33 MB.

» Once the download is complete, select 'Open' to launch the archive. In the case of Project Gutenberg, you'll see the archive resembles the website itself when viewed in Kiwix. You can scroll through titles and click to either view as html or download the eBook in .epub format elsewhere.

» When we tried to download an .epub book in Kiwix in this way, we saw that the file extension was missing. Windows also has no built-in support for reading books in this format. You can resolve this by installing a free and open-source EPUB reader, like Thorium.

3 ADD YOUR ARCHIVES (PWA VERSION)

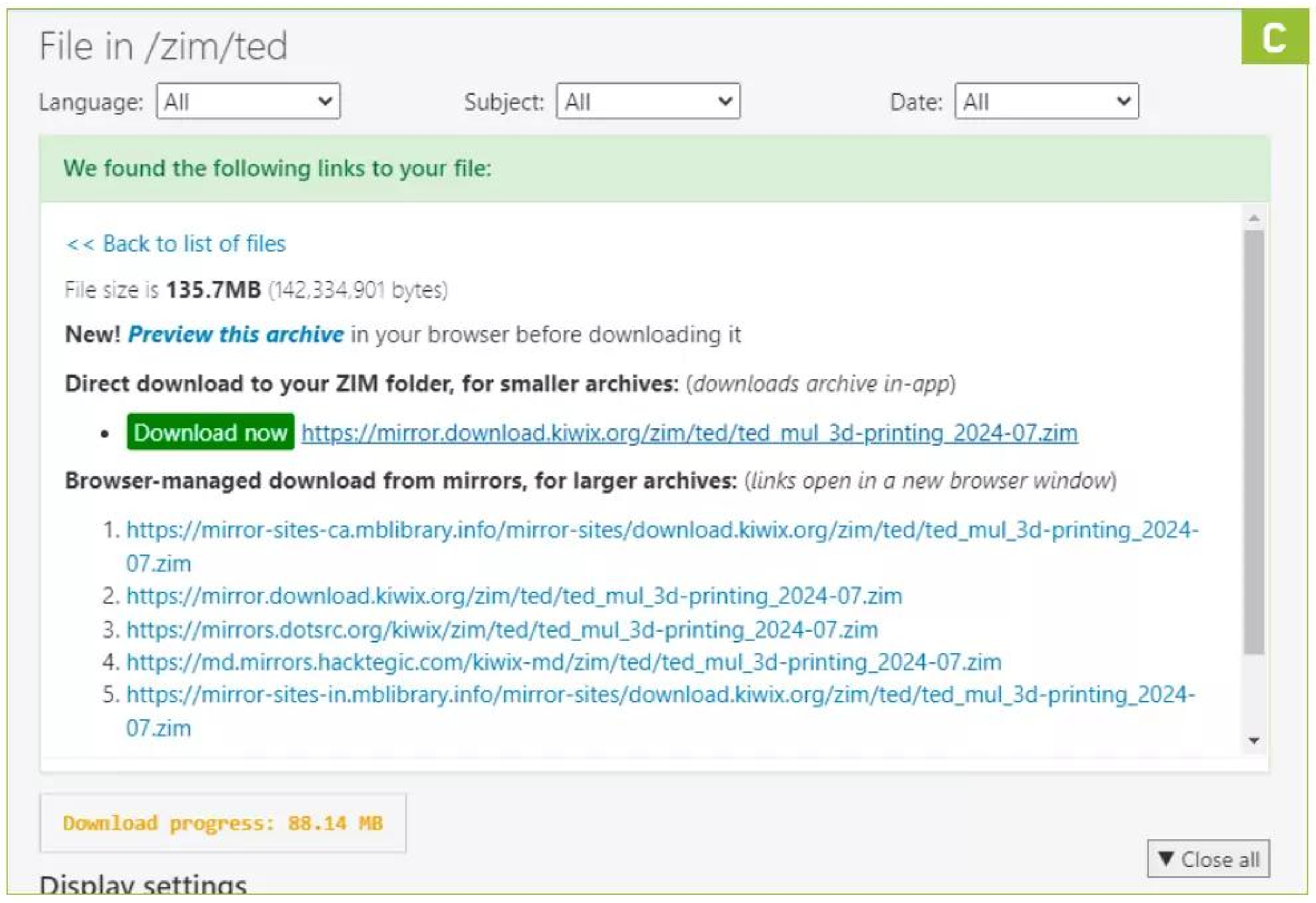
The web app version of Kiwix also supports browsing and adding archives, albeit in a slightly different way. If you installed this in the first step of the tutorial, Windows will offer to create a dedicated task bar entry and desktop shortcut. Choose as you see fit, then under 'Download library', choose 'Open library'.

» A new section will appear, labeled 'Index of /zim'. From here, you'll see a folder tree listing various categories like 'wikinews'. If you choose one of these, you will see the various .zim archives listed.

» This isn't quite as intuitive as in the standard app. For example, it takes some mental gymnastics to realize that the archive wikinews_en_all_nopic_2024-06 is all English-language stories from Wikinews for June 2024, minus any pictures.

» If you click on an archive name, you will see that the PWA version of Kiwix now supports previewing some archives before downloading them via the main website. You'll also usually be offered a list of mirrors to download the archive via your default browser.

» Once this is complete, use the buttons at the top of the Kiwix window to select a file or folder for a single or split archive respectively. If you do this, the app will ask you to confirm that the file is from a safe source. It's usually safe to choose 'Trust' source from links provided by Kiwix. If you want to play it safe, though, choose 'Open in Restricted Mode'. This will display the archive, but prevents running attached scripts in the frame. It offers an excellent way to preview archives before loading them fully. [**Image C**]


C

File in /zim/ted

Language: All Subject: All Date: All

We found the following links to your file:

<< Back to list of files

File size is **135.7MB** (142,334,901 bytes)

New! ***Preview this archive*** in your browser before downloading it

Direct download to your ZIM folder, for smaller archives: (*downloads archive in-app*)

- Download now https://mirror.download.kiwix.org/zim/ted/ted_mul_3d-printing_2024-07.zim

Browser-managed download from mirrors, for larger archives: (*links open in a new browser window*)

1. https://mirror-sites-ca.mblibrary.info/mirror-sites/download.kiwix.org/zim/ted/ted_mul_3d-printing_2024-07.zim
2. https://mirror.download.kiwix.org/zim/ted/ted_mul_3d-printing_2024-07.zim
3. https://mirrors.dotsrc.org/kiwix/zim/ted/ted_mul_3d-printing_2024-07.zim
4. https://md.mirrors.hacktegic.com/kiwix-md/zim/ted/ted_mul_3d-printing_2024-07.zim
5. https://mirror-sites-in.mblibrary.info/mirror-sites/download.kiwix.org/zim/ted/ted_mul_3d-printing_2024-07.zim

Download progress: 88.14 MB

» If you designated a folder location for the ZIM archive, Kiwix can scan it automatically for new content to save you having to browse there each time. First, click 'Open library' once again to download another ZIM archive.

» Once the download is done, scroll to the top of the Kiwix settings window, then click the refresh icon underneath the archive list. We recommend creating a dedicated folder for this purpose, as Kiwix doesn't have permission to access your regular 'Downloads' folder.

4 MANUALLY ADD ZIM ARCHIVES

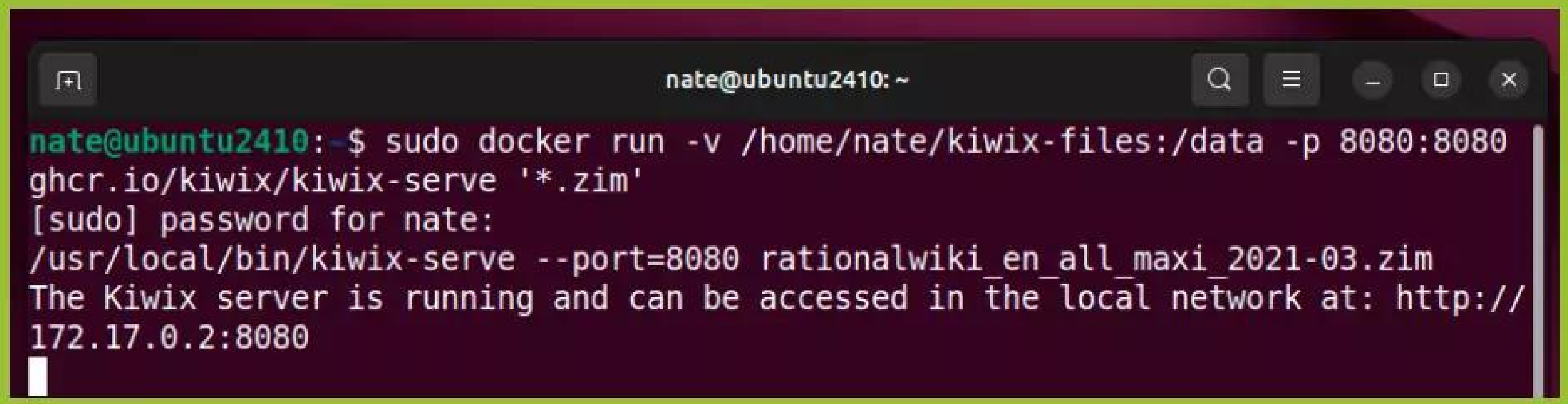
During our tests with the standard version of Kiwix, we noted that some categories, like Wikipedia, failed to load. If this also happens to you, you can manually download the ZIM archive to your machine using your web browser.

» First, navigate to https://library.kiwix.org. From here, you can filter sources by language and category using the drop-down menus at the top left. If you click into an entry, eg. 'Wikipedia Top 100 articles', you can view the archive exactly as it appears in the Kiwix app.

SET UP A KIWIX DOCKER INSTANCE

If you're planning to use Kiwix offline or only on a local area network, there's little chance of someone trying to compromise your system. However, using a secure Docker container is good practice, plus it makes it easy to move your offline data vault to another computer.

If you have a Linux server running Docker, you can install the dedicated image for kiwix-serve by running:



```
nate@ubuntu2410:~$ sudo docker run -v /home/nate/kiwix-files:/data -p 8080:8080
ghcr.io/kiwix/kiwix-serve '*.zim'
[sudo] password for nate:
/usr/local/bin/kiwix-serve --port=8080 rationalwiki_en_all_maxi_2021-03.zim
The Kiwix server is running and can be accessed in the local network at: http://
172.17.0.2:8080
```

```
docker pull ghcr.io/kiwix/kiwix-serve:3.7.0
```

Once the image is installed, if you haven't done so already set up a directory to store your ZIM files, eg.

```
mkdir kiwix-files
```

You can Kiwix serve inside a new Docker container, eg.

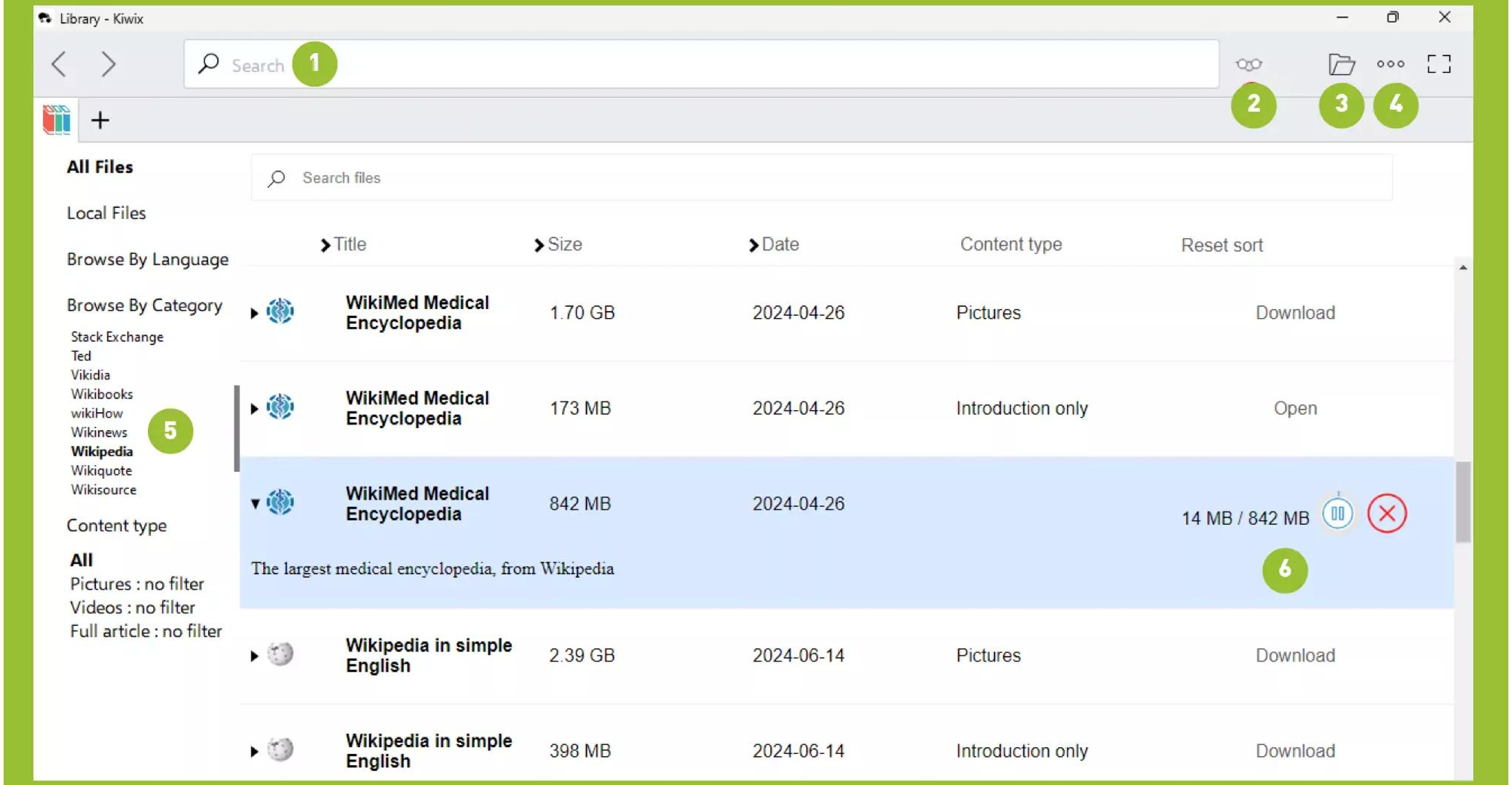
```
sudo docker run -v /home/nate/kiwix-files:/data -p 8080:8080 ghcr.io/kiwix/kiwix-serve '*.zim'
```

Here, you should substitute '/home/nate/kiwix-files' with the folder containing your ZIM files. This is mapped to the 'data' folder inside the Docker container. If we ran this command when the folder was empty, kiwix-serve wouldn't start, so download some content to it first.

The -p argument specifies the port number—change this if you wish. Once you run the command, you should see a notification in Terminal that the Kiwix server is running, along with the corresponding local IP address and port.

©KIWIX/TED›

KIWIX DESKTOP INTERFACE



Title	Size	Date	Content type	Reset sort
WikiMed Medical Encyclopedia	1.70 GB	2024-04-26	Pictures	Download
WikiMed Medical Encyclopedia	173 MB	2024-04-26	Introduction only	Open
WikiMed Medical Encyclopedia The largest medical encyclopedia, from Wikipedia	842 MB	2024-04-26		14 MB / 842 MB
Wikipedia in simple English	2.39 GB	2024-06-14	Pictures	Download
Wikipedia in simple English	398 MB	2024-06-14	Introduction only	Download

1. SEARCH BAR
Kiwix's interface is similar to a browser, allowing you to enter keywords to search for and within articles. The program may need to index an archive before it can do this.

2. READING LIST
Click here to display the current reading list. You can also add the current article by selecting the corresponding icon in the search bar while the list is open.

3. KIWIX OPTIONS
From here, you can open settings to change the default ZIM download folder. You can also launch the Kiwix local server to start sharing your library over the local network.

4. LOCAL FILES
Kiwix can download archives from the online library, but here, you can view files already on your device. Click the open icon at the top right to add ZIM files.

5. BROWSING OPTIONS
If you're choosing what content to download, these options apply filters, such as choosing English language only. The 'category' option lists archives like Wikipedia or Project Gutenberg.

6. MAIN WINDOW
From here, choose 'Download' to save a ZIM archive or 'open' to view one on your device. Click the arrow next to an archive name for a more detailed description.

To download the archive itself, click on the blue button inside the entry.

» The library supports direct downloads, as well as via a BitTorrent client. Once this is done, open the Kiwix app, and hold down Ctrl-O to navigate to your chosen archive. If you return to the main Kiwix screen, you'll see this is now listed under the 'Local Files' category. Right-click to open or delete.

» The Kiwix website's 'Zimit' tool can also create copies of websites in the open-source ZIM format. Before you do this, ensure you have the permission of the website owner to create copies of their work. [**Image D**]

» In our case, we chose the TED 'Apocalypse Survival Guide'—a series of videos on useful topics like how to purify drinking water. TED videos are released under a Creative Commons Licence. This particular series also forms part of Kiwix's 'Prepper' pack of ZIMs, which normally cost $25.

» Although there's no charge to use the 'Zimit' tool, Kiwix has limited infrastructure, so requests can take up to 24 hours to process. To get started, open the Zimit tool in your browser (https://zimit.kiwix.org). Enter the URL your wish to 'Zim' and a valid email address. Choose 'advanced options' to set metadata, like a title and description, for your archive.

5

NAVIGATING KIWIX

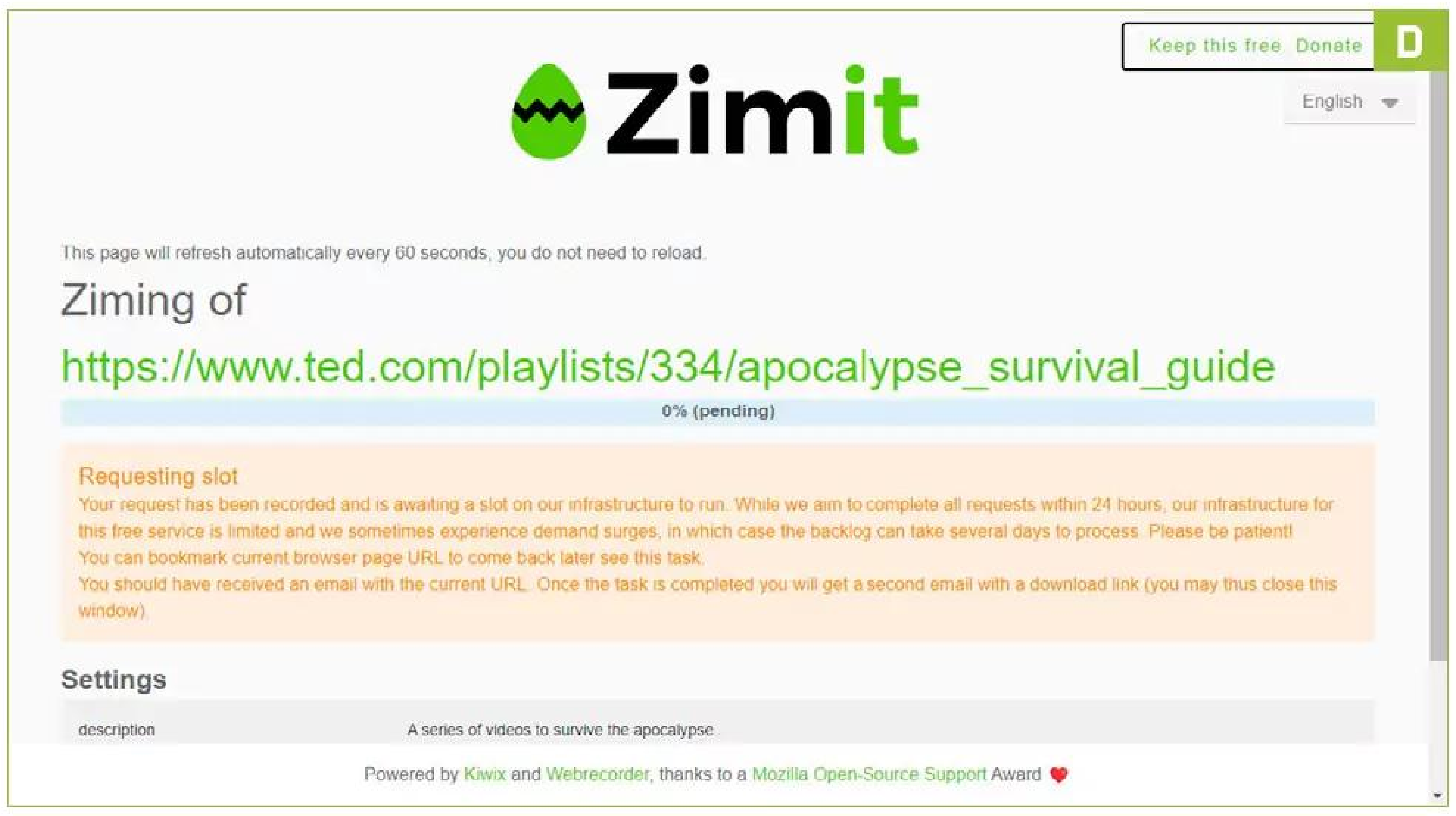
Once all your ZIM archives are downloaded, you can start to explore them using Kiwix. The standard Windows app interface is very similar to a desktop browser in that you can press F11 to enter full-screen mode. You can also open multiple tabs for individual archives or articles. There are even back and forward arrows at the top left to revisit previously opened pages.

» When viewing articles, you can use Ctrl +/- to zoom in or out respectively. Kiwix also supports printing articles. If you're using the PWA version of Kiwix, this displays extra options, including the option to print the desktop or mobile version of a page. You can also choose to print extra information like endnotes or external links.

» The standard Kiwix app has a reading list, which you can view by clicking the icon at the top right or by holding Ctrl-Shift-2. To add the current article to the reading list, simply click the corresponding icon at the start of the search bar. [**Image E**]

» You can use the search bar itself to search for a keyword, eg. 'antibiotics', which will usually list all

©LUTRIS


D

This page will refresh automatically every 60 seconds, you do not need to reload.

Ziming of

https://www.ted.com/playlists/334/apocalypse_survival_guide

0% (pending)

Requesting slot

Your request has been recorded and is awaiting a slot on our infrastructure to run. While we aim to complete all requests within 24 hours, our infrastructure for this free service is limited and we sometimes experience demand surges, in which case the backlog can take several days to process. Please be patient!
You can bookmark current browser page URL to come back later see this task.
You should have received an email with the current URL. Once the task is completed you will get a second email with a download link (you may thus close this window).

Settings

description A series of videos to survive the apocalypse

Powered by Kiwix and Webrecorder, thanks to a Mozilla Open-Source Support Award ❤

article titles containing that name. You can also choose 'fulltext' search for instances of the keyword in existing articles. If you created a ZIM archive manually in the last step, it may need to be indexed before you can run searches. Kiwix displays a pop-up if this is necessary, but be warned: it can take some time.

» If you need to find a specific term within a page, hold Ctrl-F. However, you have to press enter to actually run the search after typing your text.

» If you're using the PWA version of Kiwix, you can also customize the display via the app settings. Click 'Open All' to view all options, including setting a dark mode for the UI and articles, as well as enabling a 'Wikimedia-style' interface.

» Scroll down to 'Other display settings and search' to configure advanced options, like how to alphabetize search index results.

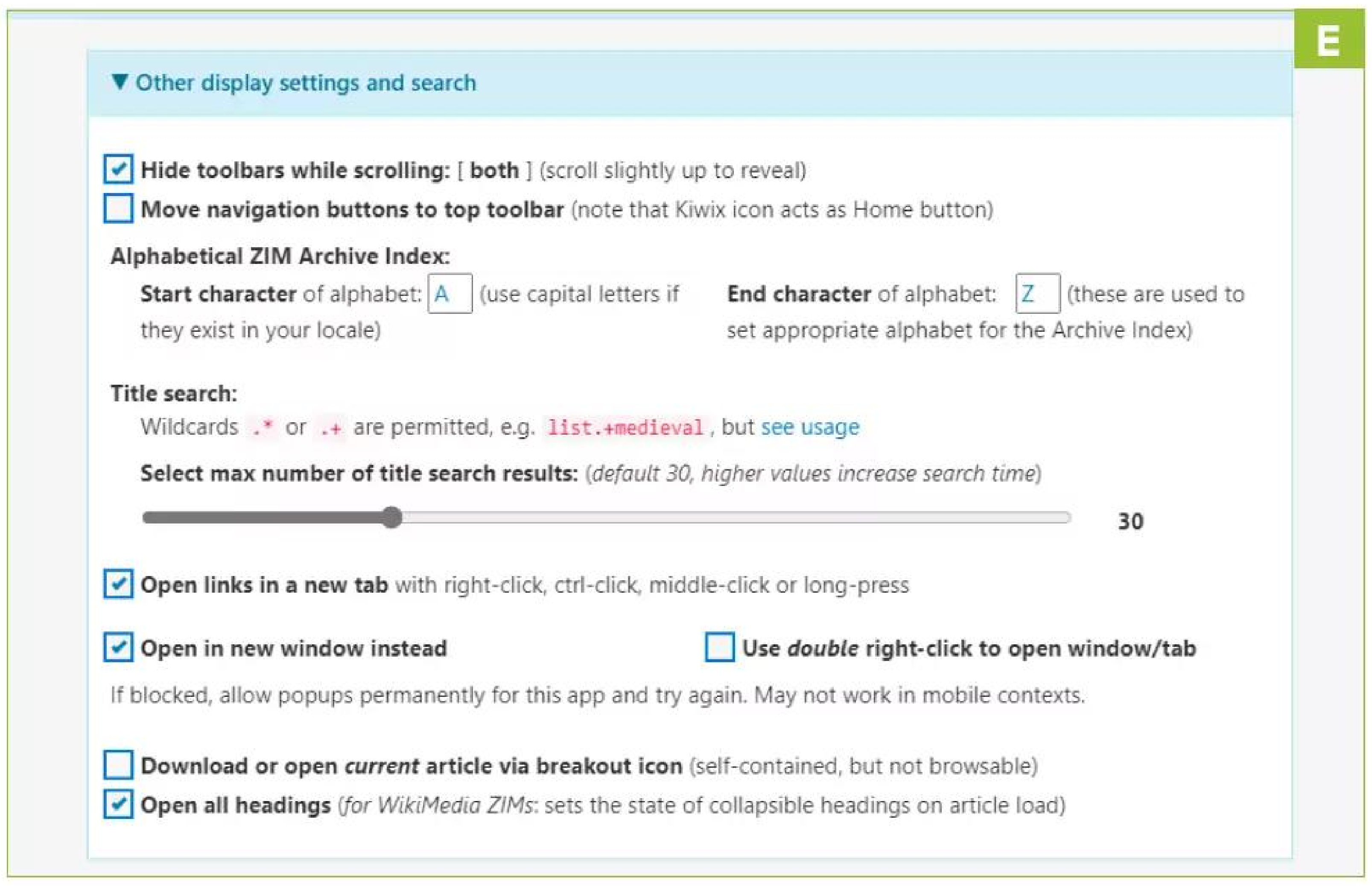
6 START YOUR KIWIX SERVER

While you may have downloaded and mastered navigating offline Kiwix content, come the apocalypse, this means only one person will be able to access this information at a time.

» Kiwix offers a number of solutions to share offline content with others. Chief among these is Kiwix Wi-Fi hotspot (https://kiwix.org/en/wifi-hotspot). The project website offers images to be written to the microSD card for a Raspberry Pi. The Pi can generate a wireless network to which your fellow survivalists can connect and view content.

» If you don't have a spare single-board computer, you can also set up a local server on your desktop machine to which others can connect.

» On the standard version of Kiwix, simply hold down Ctrl-I to summon the server dialog. From here, you can choose the relevant IP address and port which other computers in the local network can use to connect to your Kiwix library. Once you enable this, Windows Firewall will prompt you to allow incoming connections to the Kiwix app.


E

▼ Other display settings and search

☑ **Hide toolbars while scrolling:** [**both**] (scroll slightly up to reveal)
☐ **Move navigation buttons to top toolbar** (note that Kiwix icon acts as Home button)

Alphabetical ZIM Archive Index:
Start character of alphabet: A (use capital letters if they exist in your locale)
End character of alphabet: Z (these are used to set appropriate alphabet for the Archive Index)

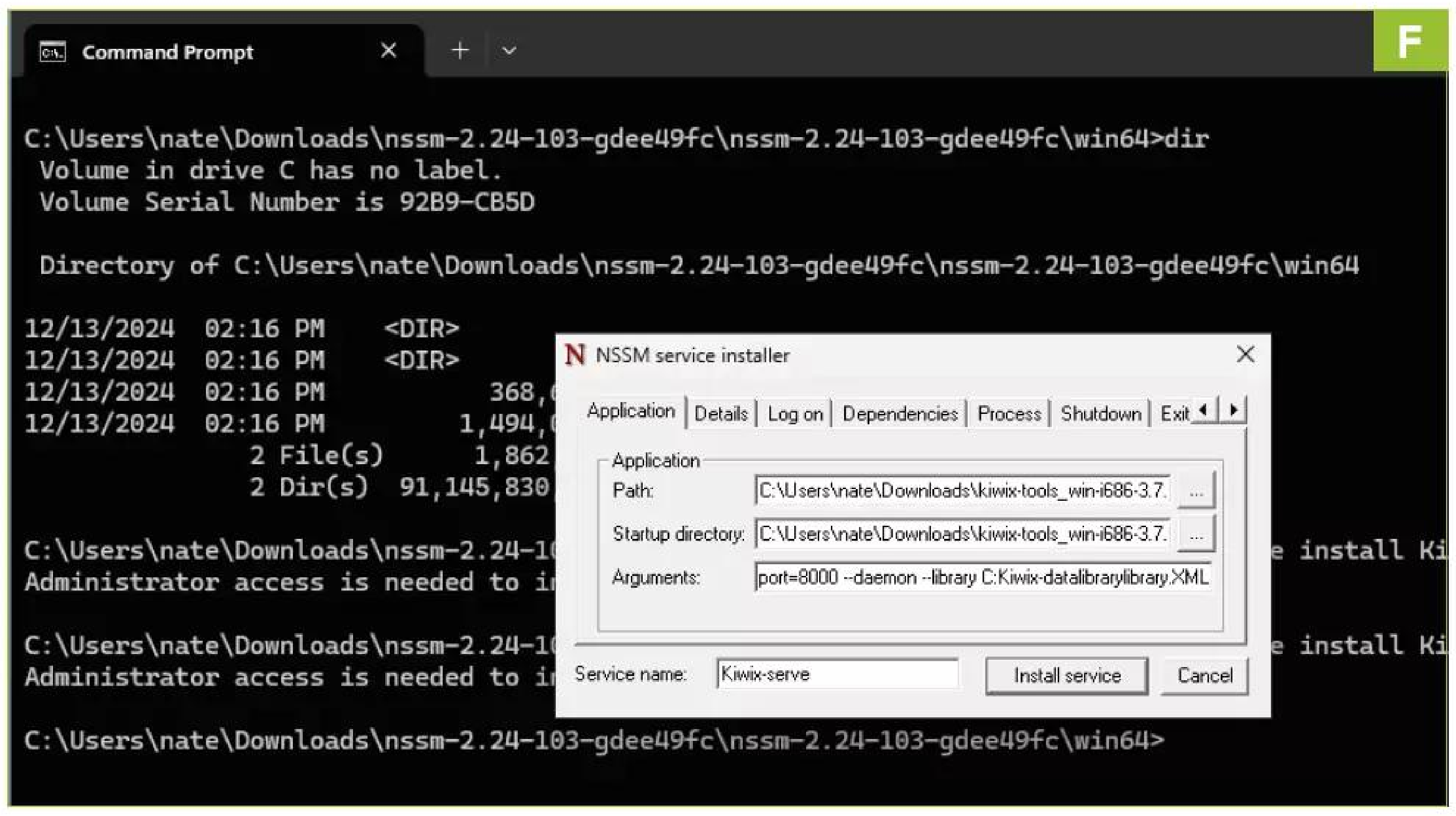
Title search:
Wildcards `.*` or `.+` are permitted, e.g. `list.+medieval`, but see usage
Select max number of title search results: (*default 30, higher values increase search time*) 30

☑ **Open links in a new tab** with right-click, ctrl-click, middle-click or long-press

☑ **Open in new window instead**
☐ **Use *double* right-click to open window/tab**
If blocked, allow popups permanently for this app and try again. May not work in mobile contexts.

☐ **Download or open *current* article via breakout icon** (self-contained, but not browsable)
☑ **Open all headings** (*for WikiMedia ZIMs*: sets the state of collapsible headings on article load)

©KIWIX, MICROSOFT/NSSM>


F

```
C:\Users\nate\Downloads\nssm-2.24-103-gdee49fc\nssm-2.24-103-gdee49fc\win64>dir
 Volume in drive C has no label.
 Volume Serial Number is 92B9-CB5D

 Directory of C:\Users\nate\Downloads\nssm-2.24-103-gdee49fc\nssm-2.24-103-gdee49fc\win64

12/13/2024  02:16 PM    <DIR>
12/13/2024  02:16 PM    <DIR>
12/13/2024  02:16 PM           368,
12/13/2024  02:16 PM         1,494,
               2 File(s)      1,862
               2 Dir(s)  91,145,830

C:\Users\nate\Downloads\nssm-2.24-1                                     e install Ki
Administrator access is needed to i

C:\Users\nate\Downloads\nssm-2.24-1                                     e install Ki
Administrator access is needed to i

C:\Users\nate\Downloads\nssm-2.24-103-gdee49fc\nssm-2.24-103-gdee49fc\win64>
```

NSSM service installer

Application
Path: C:\Users\nate\Downloads\kiwix-tools_win-i686-3.7.
Startup directory: C:\Users\nate\Downloads\kiwix-tools_win-i686-3.7.
Arguments: port=8000 --daemon --library C:Kiwix-datalibrarylibrary.XML
Service name: Kiwix-serve

» Once the server starts, choose 'Open in browser' to double-check that it's running. Naturally, you should also try to access the Kiwix library from another device on your local network.

» From what we saw in our tests, the PWA version of Kiwix doesn't support this feature. However, you can install 'Kiwix Serve' from the Kiwix downloads page which works as a standalone server application.

» If you do this in Windows, download the relevant binaries. Next, extract the 'kiwix-tools' ZIP archive, then open the command prompt. Use 'CD' to navigate to the kiwix-tools folder. You can make ZIM files available using kiwix-serve.exe, eg:

```
kiwix-serve.exe --port=8000 C:\Users\nate\Downloads\ZIMS\3dprinting.stackexchange.com_en_all_2024-01.zim --library --daemon
```

» During our tests, we found that while this worked with ZIM files directly downloaded via Kiwix, the archives we downloaded manually failed to load in the browser. This is likely due to the lack of a corresponding XML library file.

7 SET UP KIWIX AS A WINDOWS SERVICE

While you can run the standard Kiwix desktop app as a server, this means the program must be open at all times (even if minimized) for others to access your offline archives. Alternatively, you can set Kiwix-serve to run as a background service in Windows.

» To get started, download the latest version of NSSM (Non-Sucking Service Manager) from https://nssm.cc/builds. Once the ZIP file downloads, extract it then open the Windows command prompt. [Image F]

» Use 'cd' to navigate to the 'Win64' subfolder of the nssm folder in your downloads. Next, run:

```
nssm install Kiwix-serve
```

» The nssm GUI will now open. Click the … next to 'Path', and navigate to the folder where kiwix-serve is installed. Use 'arguments' to specify that this is a background process, the port on which it should run and the location of your library file e.g. --port=8000 --daemon --library C:Kiwix-datalibrarylibrary.XML

» Click the 'Details' tab to add a name and meaningful description for your new service, eg. 'Provides an http server on port 8000 for Kiwix ZIM archives', and, choose 'Install Service' to set it up. If you click this too early, return to the command prompt and run:

```
nssm edit kiwix-serve
```

» Use `nssm start kiwix-serve` to start the service. You can double-check it's running properly by opening services.msc. Kiwix-serve should now be listed there.

Boost your Wi-Fi

YOU'LL NEED THIS

USB WI-FI ANTENNA
(optional)

ROUTER
with open source
firmware (optional)

WHEN WIRELESS NETWORKS were introduced in the 1990s, they were widely derided as being clunky, slow, and prone to interference. The first widely adopted wireless networking standard (802.11b) offered speeds of just 11 Mbps. In other words, it would have taken at least 12 minutes to copy a 1GB file from one network device to another.

The introduction of subsequent Wi-Fi standards like 802.11n and 802.11ac welcomed new wireless bands, channels, and other features for optimizing wireless performance. That said, Wi-Fi can still be prone to slow speeds, dropped connections, and wireless interference.

This is particularly true if you live in an area with multiple access points and devices that can crowd out existing radio frequencies very quickly. This tutorial focuses on some basic steps you can take to improve the Wi-Fi signal in your home. This includes selecting and positioning the right router, as well as tweaking your Wi-Fi channels for optimum performance. –**NATE DRAKE**

1 ELIMINATE INTERFERENCE

Fundamentally, Wi-Fi is a line-of-sight radio technology. In other words, it doesn't work by surrounding your device with a wireless signal, but by forming a direct connection.

» There are simple steps you can take to facilitate this if you're finding that your wireless signal is weak and/or intermittent. Typically, placing your router in a central location will provide the best Wi-Fi signal across your home.

» If there are multiple floors in your building, but the router's on the ground floor, place it on a high access point like a shelf to strengthen the signal. Walls, floors, and metal objects are all potential sources of interference. Even repositioning your router by a few inches can make a huge difference.

» If your router does have an antenna, it's most likely omnidirectional. In other words, it's designed to provide Wi-Fi coverage in as close an approximation to a perfect sphere as possible. This Decibel-isotropic (dBi) value is calculated by combining the number of decibels with the Antenna 'gain'.

» Generally, the higher the gain, the more directional an antenna. This means that theoretically, you could replace the omni-directional antennas on your router with 'high-gain' ones.

» This can improve Wi-Fi signal strength for specific devices. A good analogy for this is to imagine narrowing the beam on a flashlight to see an object more clearly. This can be useful if you have a device in a fixed location like a Wi-Fi repeater. However, if you want a reliable Wi-Fi network, it's likely that you'll need to be able to connect from multiple locations.

» Instead of using high-gain antennas, consider buying a router with multiple omni-directional ones instead like the ASUS ROG Rapture GT-AX11000. [**Image A**]

» Using a more modern router also ensures that you'll be using Wi-Fi 6 or greater. This includes optimization features like MU-MIMO (Multi-User, Multiple-Input, Multiple-Output), which can handle up to eight simultaneous data streams.

» It also supports OFDMA (Orthogonal Frequency Division Multiple Access), allowing WI-Fi channels to be broken down into smaller sub-channels. This allows multiple devices to transmit simultaneously with less interference compared to previous wireless standards.

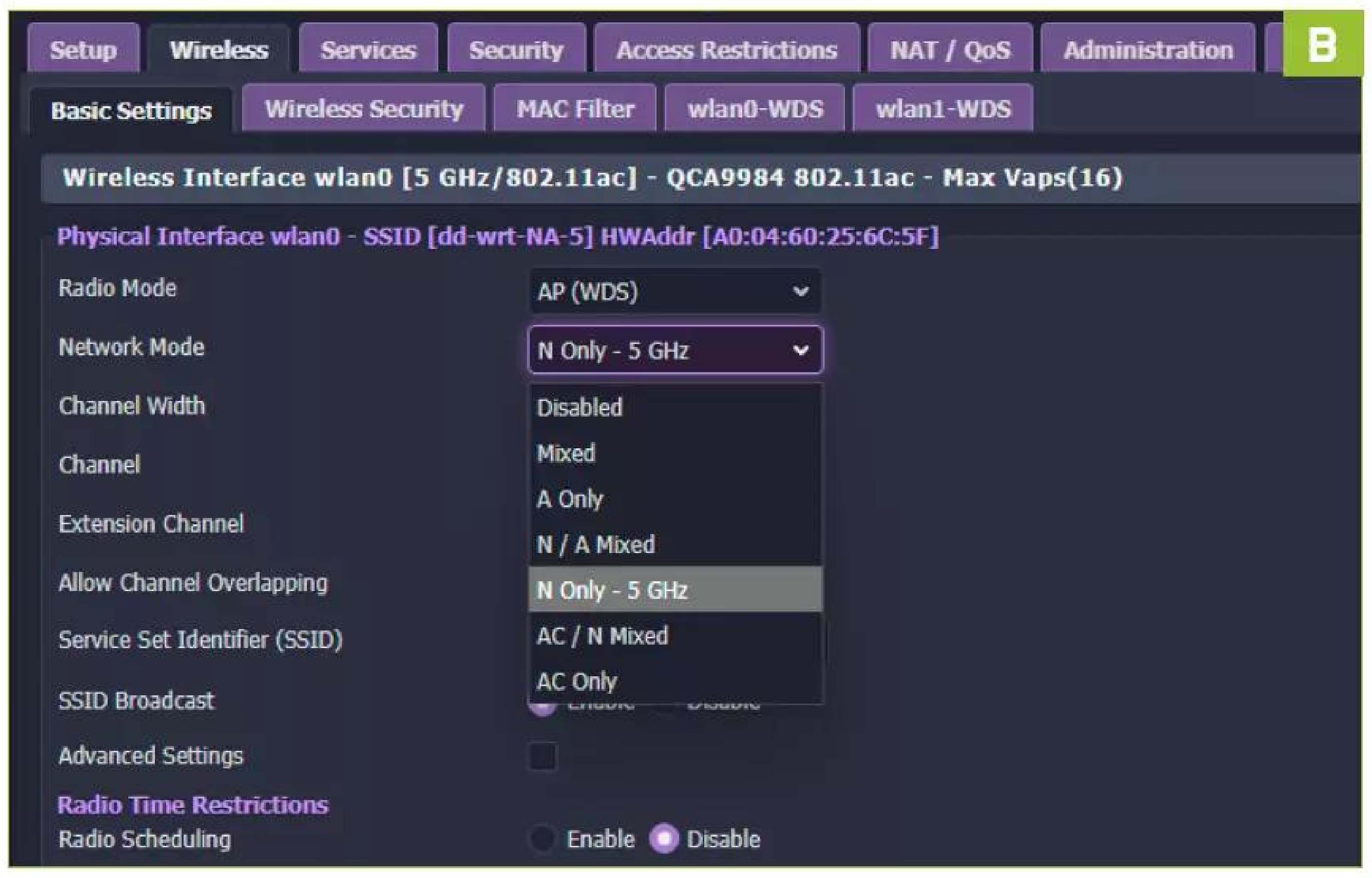
2 CHECK YOUR CHANNELS

The most common wireless tech, 802.11g (wireless-G), operates at 2.4GHz. This means that simply switching your wireless network to use the 5GHz or 6GHz band can eliminate most sources of interference and offer faster speeds. [**Image B**] However, it can also reduce your wireless range.

» Whichever band or bands you deploy, you can also improve Wi-Fi performance by avoiding channels that are too congested. By default, your router automatically selects these, but doesn't always switch to channels with more capacity when the original channel becomes crowded.

» The specific steps for manually configuring your channel will vary depending on your firmware. For instance, if you're using a DD-WRT router (which we strongly recommend), there's a dedicated channel drop-down menu under 'Wireless' > 'Basic Settings'. [**Image C**]

» Naturally, it helps to know which channels are the least used in your area. One of the best tools for this is WinFi. You can download the installer from https://github.com/HelgeKeck/winfi/releases). When WinFi launches, it will display all the wireless networks in your area, along with the channels they use (in the 'CH' column). [**Image D**]



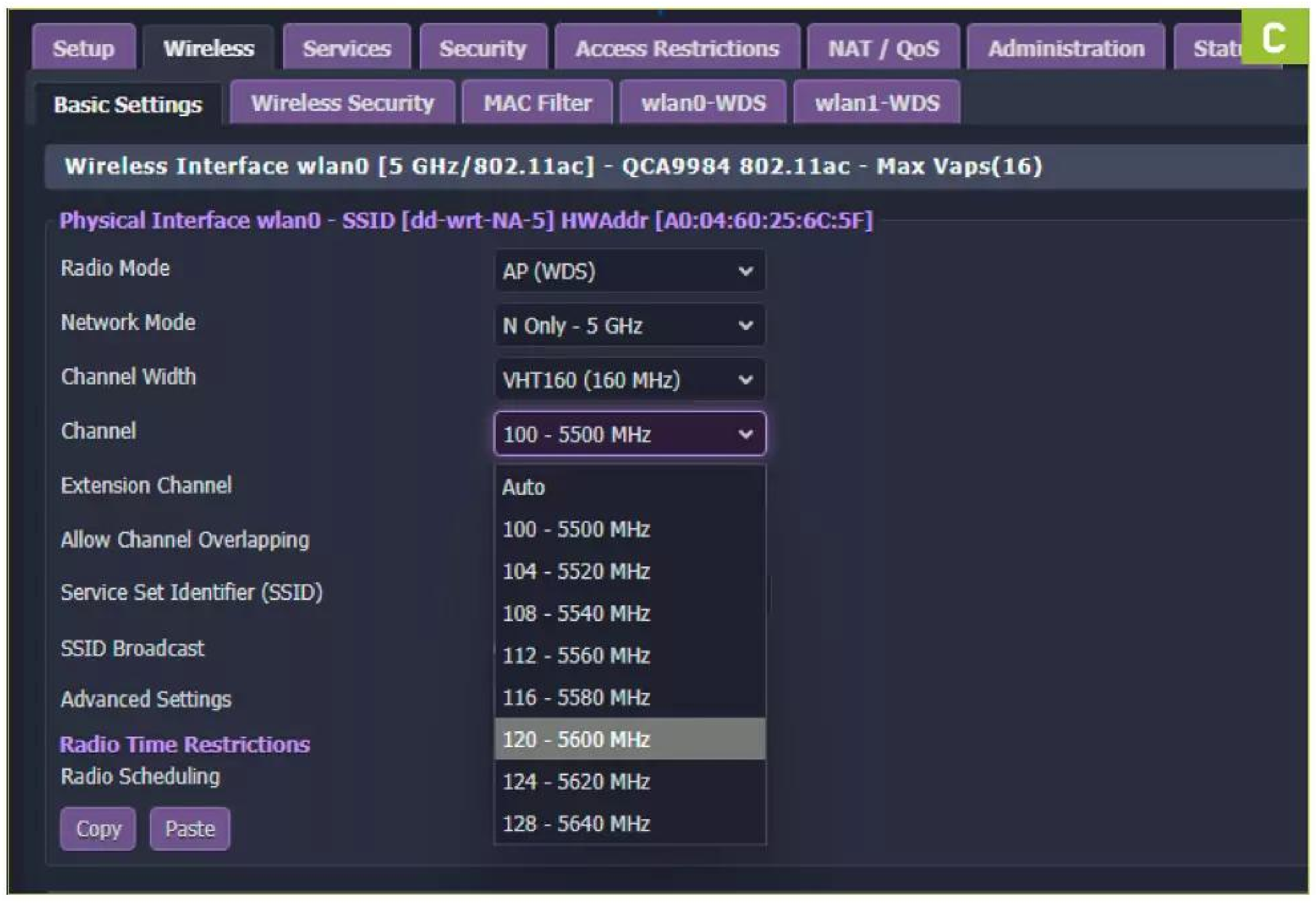
Wireless Interface wlan0 [5 GHz/802.11ac] - QCA9984 802.11ac - Max Vaps(16)

Physical Interface wlan0 - SSID [dd-wrt-NA-5] HWAddr [A0:04:60:25:6C:5F]

Radio Mode: AP (WDS)
Network Mode: N Only - 5 GHz
Channel Width
Channel
Extension Channel
Allow Channel Overlapping
Service Set Identifier (SSID)
SSID Broadcast
Advanced Settings ☐

Radio Time Restrictions
Radio Scheduling ○ Enable ● Disable

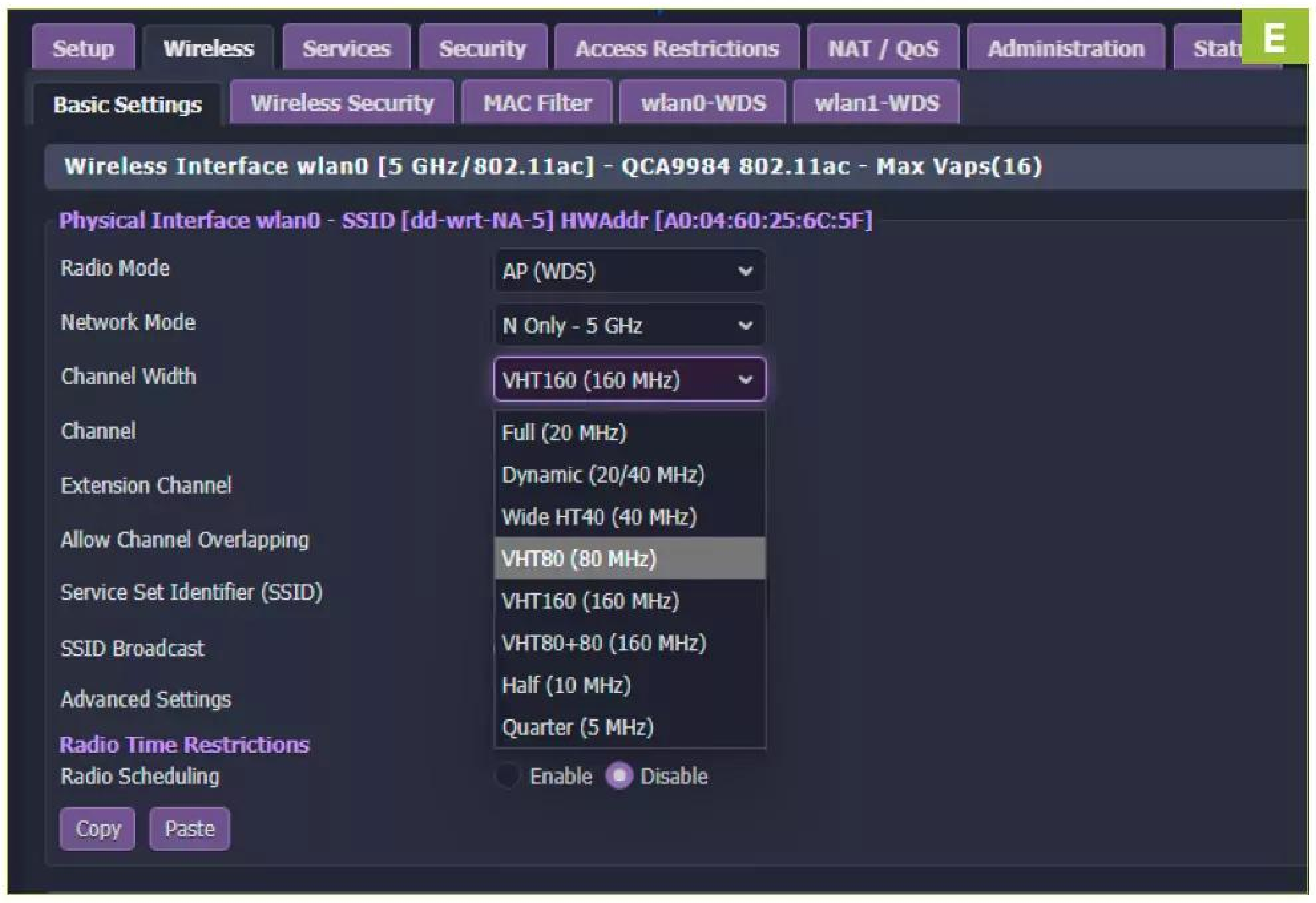
© ASUS, DD-WRT.COM



Wireless Interface wlan0 [5 GHz/802.11ac] - QCA9984 802.11ac - Max Vaps(16)

Physical Interface wlan0 - SSID [dd-wrt-NA-5] HWAddr [A0:04:60:25:6C:5F]

Radio Mode: AP (WDS)
Network Mode: N Only - 5 GHz
Channel Width: VHT160 (160 MHz)
Channel: 100 - 5500 MHz
Extension Channel
Allow Channel Overlapping
Service Set Identifier (SSID)
SSID Broadcast
Advanced Settings
Radio Time Restrictions
Radio Scheduling



Wireless Interface wlan0 [5 GHz/802.11ac] - QCA9984 802.11ac - Max Vaps(16)

Physical Interface wlan0 - SSID [dd-wrt-NA-5] HWAddr [A0:04:60:25:6C:5F]

Radio Mode: AP (WDS)
Network Mode: N Only - 5 GHz
Channel Width: VHT160 (160 MHz)
Channel
Extension Channel
Allow Channel Overlapping
Service Set Identifier (SSID)
SSID Broadcast
Advanced Settings
Radio Time Restrictions
Radio Scheduling: ○ Enable ● Disable

» On the 2.4GHz band, Wi-Fi operates on channels 1 to 14. Note down the least frequently used of these. Typically, channels 1, 11, and 6 receive the least interference. The channels supported on each band can vary based on where your router was manufactured. For example, European routers often support channels 12 and 13. Check the 'CC' column in WinFi to discover the country code for which your Access Point has been configured.

» Wi-Fi networks on the 5GHz band operate on channels 36 to 165. In the case of this band, try to find a channel that's as far away from the others as possible.

» The 6GHz band has 59 available channels, and supports 'Preferred Scanning Channels' (PSC) to manage channel discovery. If you're using this band, you're unlikely to experience channel congestion.

» If you have any Wi-Fi range extenders or other APs, make sure that these use a different channel to your main router. This may sound counter-intuitive, but even a single Wi-Fi router with multiple radio signals can conflict with itself if they're all using the same channel.

3

CHANGE YOUR CHANNEL WIDTH

Each Wi-Fi channel is allotted a certain 'width'. For instance, the traditional 802.11 standard allotted 20MHz to each channel in the 2.4GHz band. The subsequent 802.11n standard introduced the concept of 'channel bonding', ie. combining 2 x 20MHz channels into a single 40MHz one.

» Generally speaking, the wider a channel, the greater the potential network speed. In the case of 802.11, this effectively doubled the throughput of each channel. The 802.11ac standard has even more bonding options to create 80MHz and 160MHz channels. However, increasing channel width can actually decrease network speed. This is because bonding multiple overlapping channels can cause interference. For instance, in the 2.4GHz band, eight out of the 11 channels overlap.

» This means you have to approach tweaking your channel widths with caution. Firstly, make sure that the feature is supported by your router. For example, if you're using DD-WRT there's a dedicated 'Channel Width' drop-down menu under 'Wireless'>'Basic Settings'.

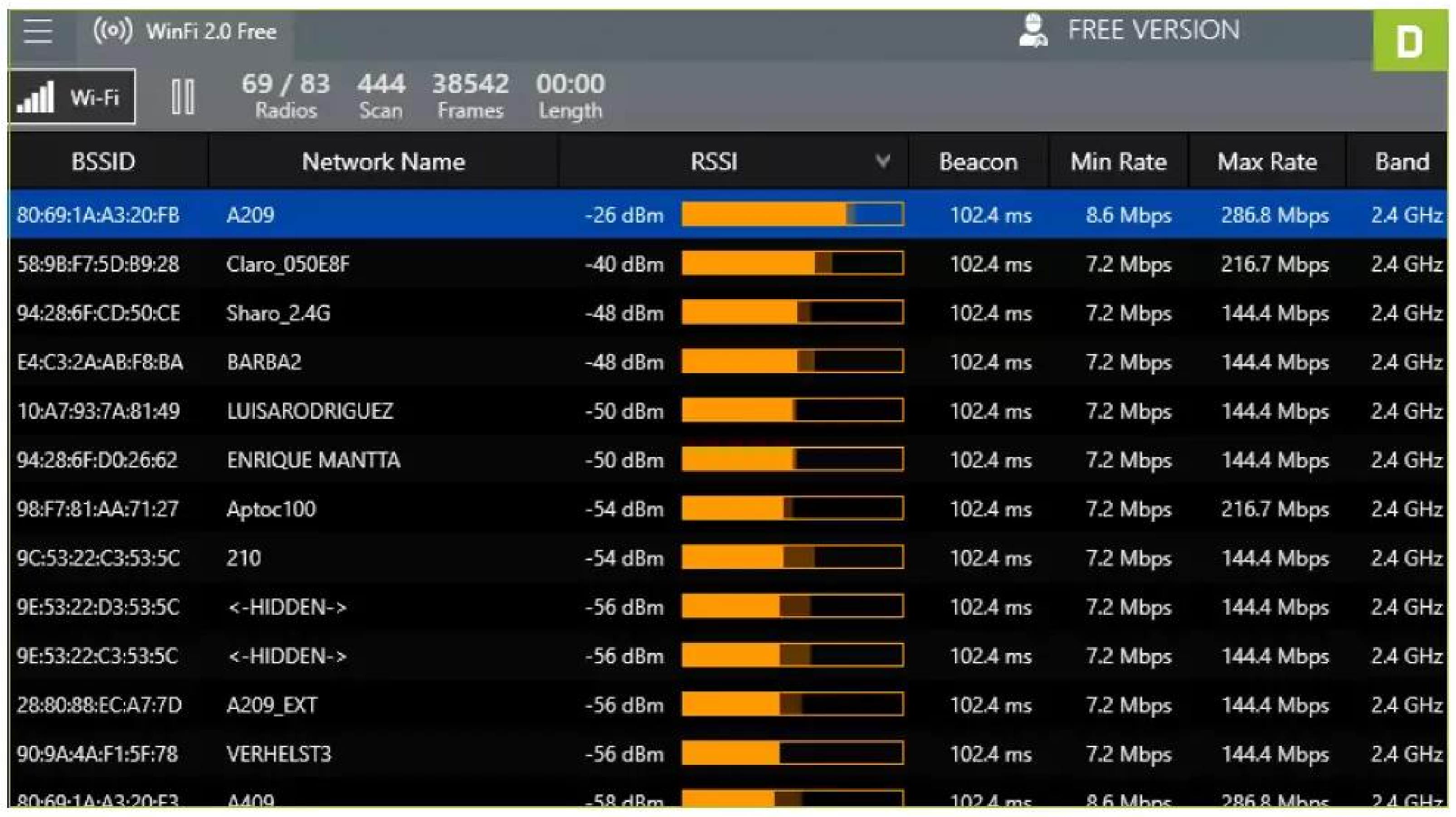
» If you're using the 2.4Ghz band, it's best to set the channel width to 20MHz to avoid overlapping. However, the 5GHz band is more flexible. This is because 24 out of its 45 channels don't overlap. In this case, try changing the channel width to 40MHz or 80MHz to see if the signal improves. [**Image E**]

» Remember that not all Wi-Fi devices may support your chosen channel width. If they're not connecting, check if your router supports enabling multiple channel widths simultaneously.

» If you find that devices keep losing their connection, you can also experiment with narrowing the channel width. Although this can impact the theoretical data throughput between data and devices, in practice, the channel is less likely to be subject to interference.

» Your router may also support more advanced features, like Time Division Multiple Access (TDMA). This assigns time slots to devices so that each can use channels in rapid succession without interference from each other. Select router firmware like DD-WRT also supports 'noise immunity', which instructs your router to ignore certain irrelevant signals by tuning driver parameters. [**Image F**]

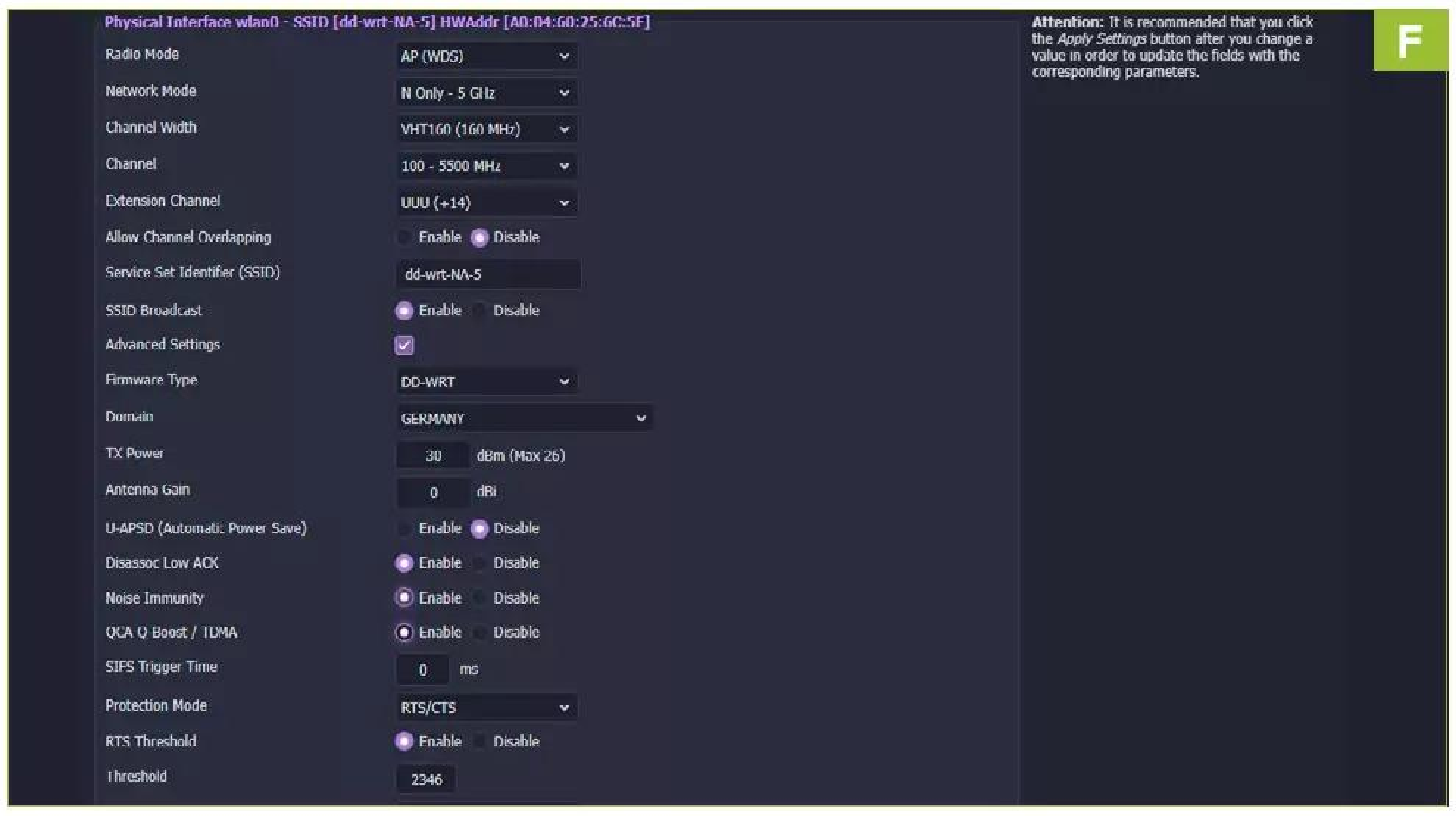
» Ultimately, it takes time to determine which exact settings will perform well with your chosen wireless network. Keep experimenting to find the best configuration for your devices. ⏻



69 / 83 Radios · 444 Scan · 38542 Frames · 00:00 Length

BSSID	Network Name	RSSI	Beacon	Min Rate	Max Rate	Band
80:69:1A:A3:20:FB	A209	-26 dBm	102.4 ms	8.6 Mbps	286.8 Mbps	2.4 GHz
58:9B:F7:5D:B9:28	Claro_050E8F	-40 dBm	102.4 ms	7.2 Mbps	216.7 Mbps	2.4 GHz
94:28:6F:CD:50:CE	Sharo_2.4G	-48 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
E4:C3:2A:AB:F8:BA	BARBA2	-48 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
10:A7:93:7A:81:49	LUISARODRIGUEZ	-50 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
94:28:6F:D0:26:62	ENRIQUE MANTTA	-50 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
98:F7:81:AA:71:27	Aptoc100	-54 dBm	102.4 ms	7.2 Mbps	216.7 Mbps	2.4 GHz
9C:53:22:C3:53:5C	210	-54 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
9E:53:22:D3:53:5C	<-HIDDEN->	-56 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
9E:53:22:C3:53:5C	<-HIDDEN->	-56 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
28:80:88:EC:A7:7D	A209_EXT	-56 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz
90:9A:4A:F1:5F:78	VERHELST3	-56 dBm	102.4 ms	7.2 Mbps	144.4 Mbps	2.4 GHz

© WINFI



Physical Interface wlan0 - SSID [dd-wrt-NA-5] HWAddr [A0:04:60:25:6C:5F]

Radio Mode: AP (WDS)
Network Mode: N Only - 5 GHz
Channel Width: VHT160 (160 MHz)
Channel: 100 - 5500 MHz
Extension Channel: UUU (+14)
Allow Channel Overlapping: ○ Enable ● Disable
Service Set Identifier (SSID): dd-wrt-NA-5
SSID Broadcast: ● Enable ○ Disable
Advanced Settings: ☑
Firmware Type: DD-WRT
Domain: GERMANY
TX Power: 30 dBm (Max 26)
Antenna Gain: 0 dBi
U-APSD (Automatic Power Save): ○ Enable ● Disable
Disassoc Low ACK: ● Enable ○ Disable
Noise Immunity: ● Enable ○ Disable
QCA Q Boost / TDMA: ● Enable ○ Disable
SIFS Trigger Time: 0 ms
Protection Mode: RTS/CTS
RTS Threshold: ● Enable ○ Disable
Threshold: 2346

Attention: It is recommended that you click the *Apply Settings* button after you change a value in order to update the fields with the corresponding parameters.

What's new in Microsoft PowerToys?

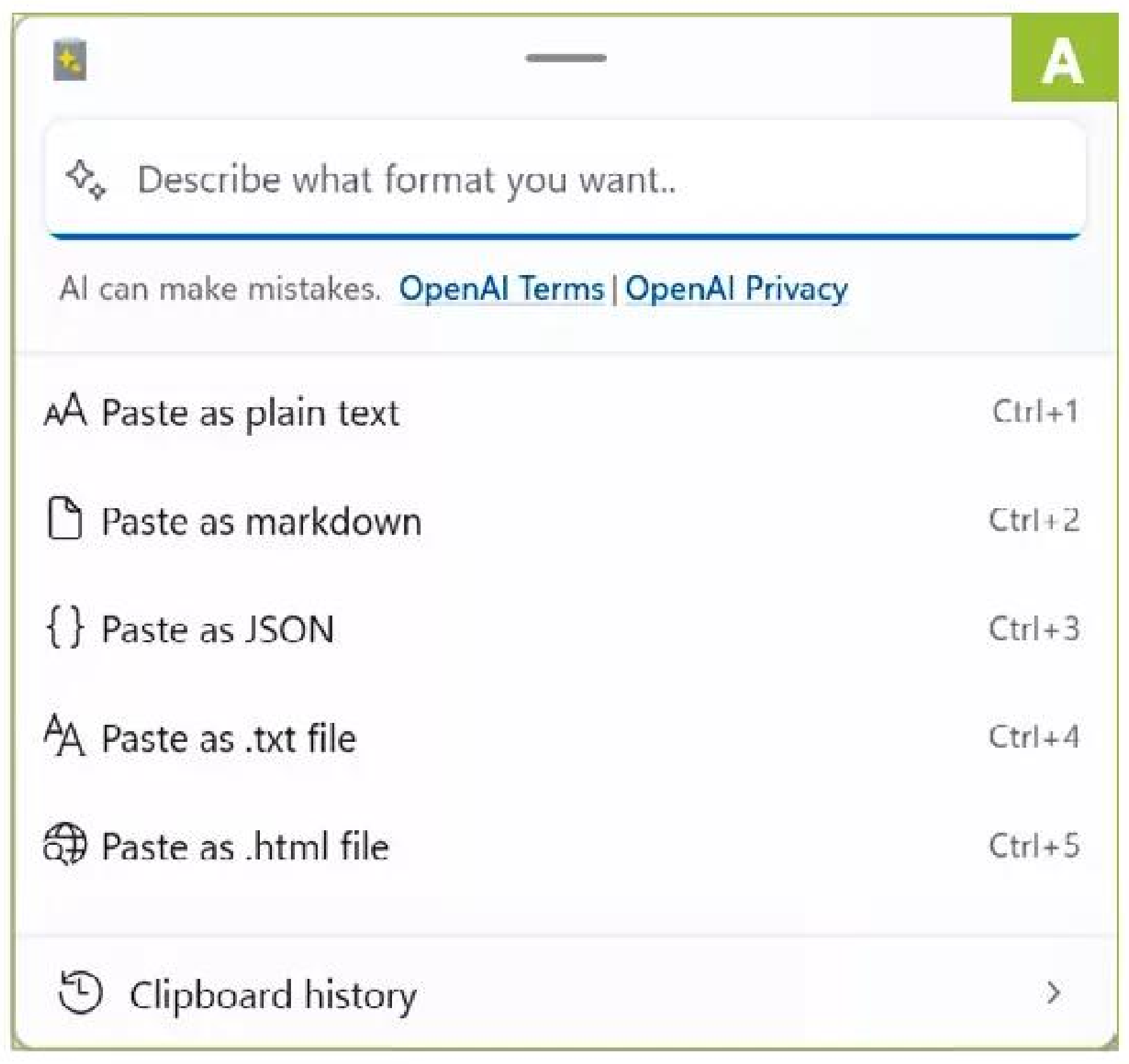
YOU'LL NEED THIS

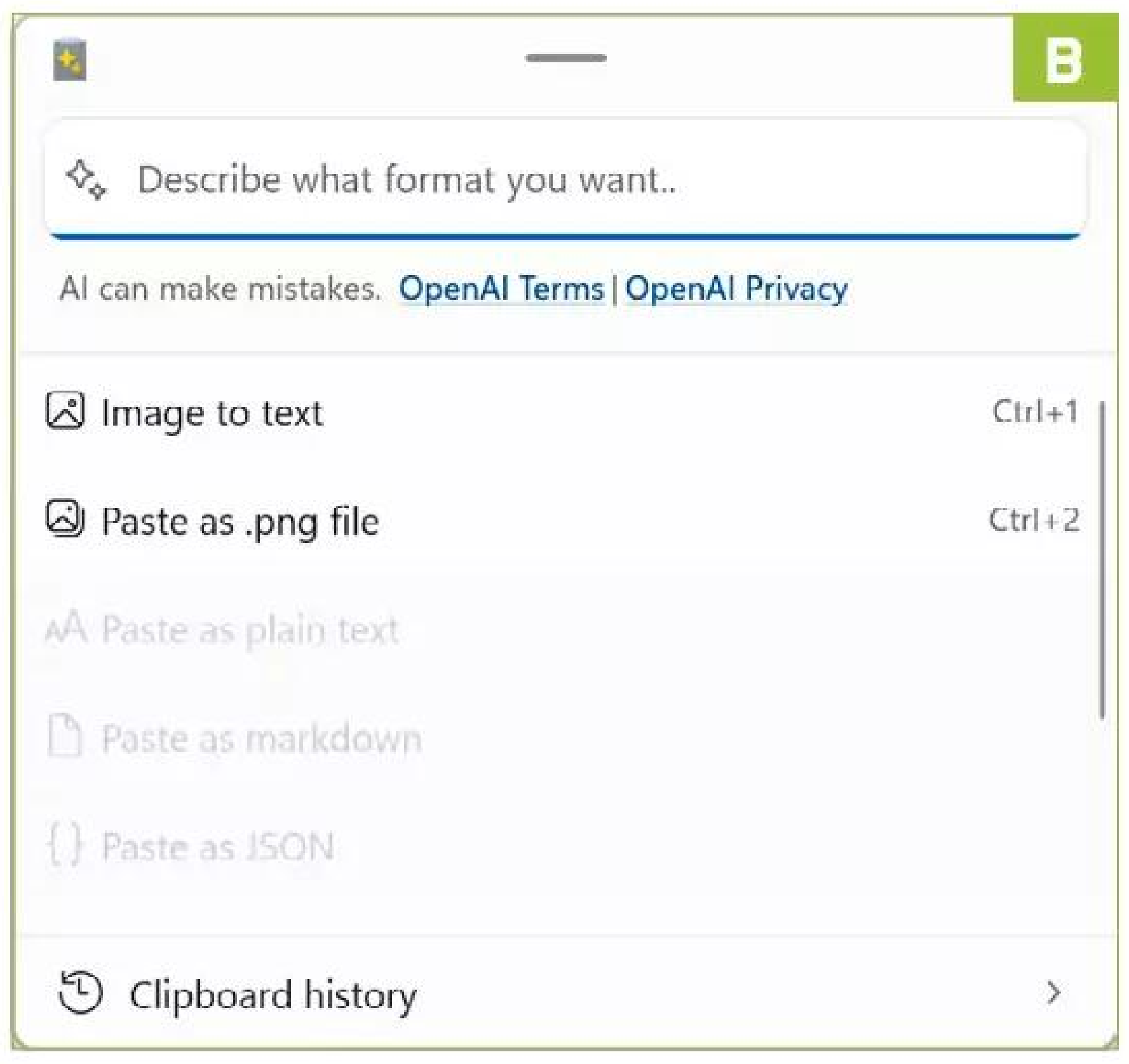
WINDOWS 10 OR 11 PC
POWERTOYS 0.86
or later

WE'VE COVERED POWERTOYS before in this magazine, but the beauty of Microsoft's open-source approach to the software is that it's constantly evolving, and new features are being added all the time. This means that if you already have the handy utility pack installed on your PC, it can be worth investigating its GitHub page or Settings window to see if an update has been posted since your last visit, as it doesn't get them through Windows Update.

Launched on GitHub in September 2019, but with a history going back much further, PowerToys for Windows 10 and 11 is an optional add-on aimed at power users. Even if you aren't in this category, you can still get something useful in its selection of utilities. We find PowerRename, which lets you rename groups of files, to be very useful, even though it's not exactly going deep into the PC's settings or capabilities. Likewise, the ability to quickly preview an image or measure across the screen can be useful, even if you only use it occasionally.

There have been plenty of additions to PowerToys since the last time we looked at it, so here are some of the new tools. –IAN EVENDEN


A
Describe what format you want..
AI can make mistakes. OpenAI Terms | OpenAI Privacy
Paste as plain text Ctrl+1
Paste as markdown Ctrl+2
Paste as JSON Ctrl+3
Paste as .txt file Ctrl+4
Paste as .html file Ctrl+5
Clipboard history


B
Describe what format you want..
AI can make mistakes. OpenAI Terms | OpenAI Privacy
Image to text Ctrl+1
Paste as .png file Ctrl+2
Paste as plain text
Paste as markdown
Paste as JSON
Clipboard history

1 ADVANCED PASTE FOR TEXT

We all know about Ctrl-V, and most people are aware of Ctrl-Shift-V (paste without formatting) and Win-V (clipboard history), but Advanced Paste (Win-Shift-V) gives you even more options for pasting text **[Image A]**. Paste as plain text is there, as is paste as JSON or markdown. You can paste as a .txt or .html file. At the top of the Advanced Paste window is an AI prompt box that allows you to type in the format you like, and your text is then analyzed and formatted by an OpenAI LLM before being pasted. You'll need an API key to make this work, and there's a disclaimer on it that AI can make mistakes, but potential uses Microsoft puts forward for it are generating code from the definition of a function that's been copied to the clipboard, rewriting copied text in a particular style before pasting, or summarizing long passages of text then pasting the shorter version.

2 ADVANCED PASTE FOR IMAGES

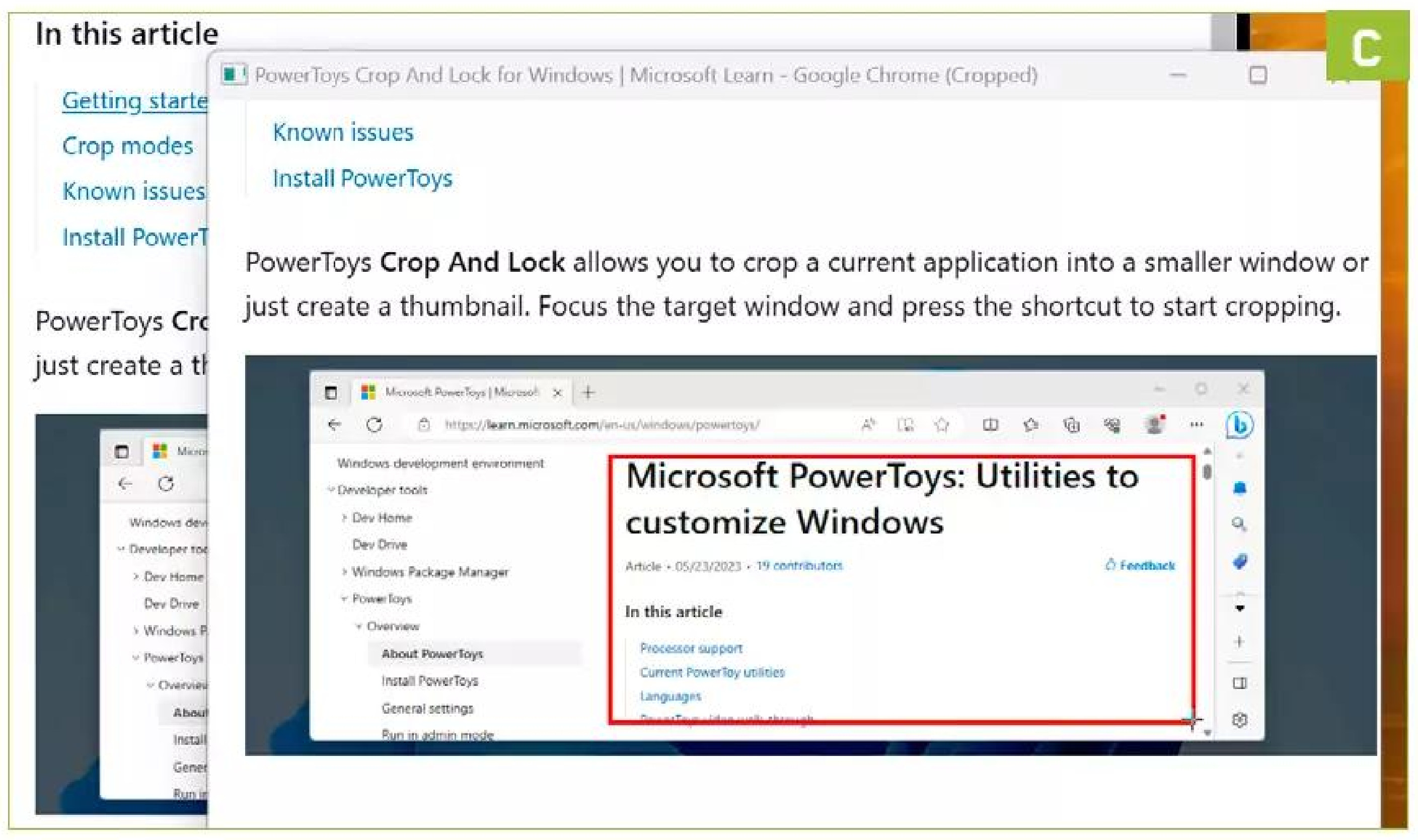
If you've got an image on your clipboard, Advanced Paste gives you a couple options **[Image B]**. Image to Text extracts any text from the image, then places it on your clipboard so you can paste it into a document. This runs using local OCR, so no API key is needed. Paste as a .png File is a fairly self-explanatory option—select an Explorer window, and you can paste an image from your clipboard as a .png file with the title PowerToys_Paste, followed by the date and time. Again, it doesn't use AI, so is quick to execute.

3 CROP AND LOCK

This lets you select one part of an application window to display. If you're watching a video, and don't want to see the surrounding interface, you can use Crop and Lock to concentrate on the video part, or isolate a region of text for easy reading. It comes in two modes: Thumbnail mode (Win-Ctrl-Shift-T) creates a new, cropped window that's tied to the original **[Image C]**, and will scroll as you move the original, but won't allow you to move anything within the cropped window itself. Reparent mode (Win-Ctrl-Shift-R) replaces the original window with the cropped one, and you can scroll text within it. Close this, and the original reappears. Microsoft warns that some apps may not work well with Crop and Lock, but it's worth testing it out.

4 FILE EXPLORER ADD-ONS

The Preview pane in the Windows File Explorer gets an upgrade of the File Explorer add-on PowerToy. If you work with markdown, Gcode, SVG, or QOI images, or even PDFs, you can see them in the Preview pane of Explorer. Apart from PDFs, these aren't common file types, but for those who use them frequently, this may be useful. File Explorer Add-ons has its own settings page from the PowerToys Dashboard, from where you can toggle support for formats. This PowerToy is also able to generate thumbnails for the same file formats, handled by a second row of settings.


C
In this article
Getting starte
Crop modes
Known issues
Install PowerT
PowerToys Crop And Lock for Windows | Microsoft Learn - Google Chrome (Cropped)
Known issues
Install PowerToys

PowerToys **Crop And Lock** allows you to crop a current application into a smaller window or just create a thumbnail. Focus the target window and press the shortcut to start cropping.

https://learn.microsoft.com/en-us/windows/powertoys/
Windows development environment
Developer tools
Dev Home
Dev Drive
Windows Package Manager
PowerToys
Overview
About PowerToys
Install PowerToys
General settings
Run in admin mode
Microsoft PowerToys: Utilities to customize Windows
Article • 05/23/2023 • 19 contributors
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In this article
Processor support
Current PowerToy utilities
Languages

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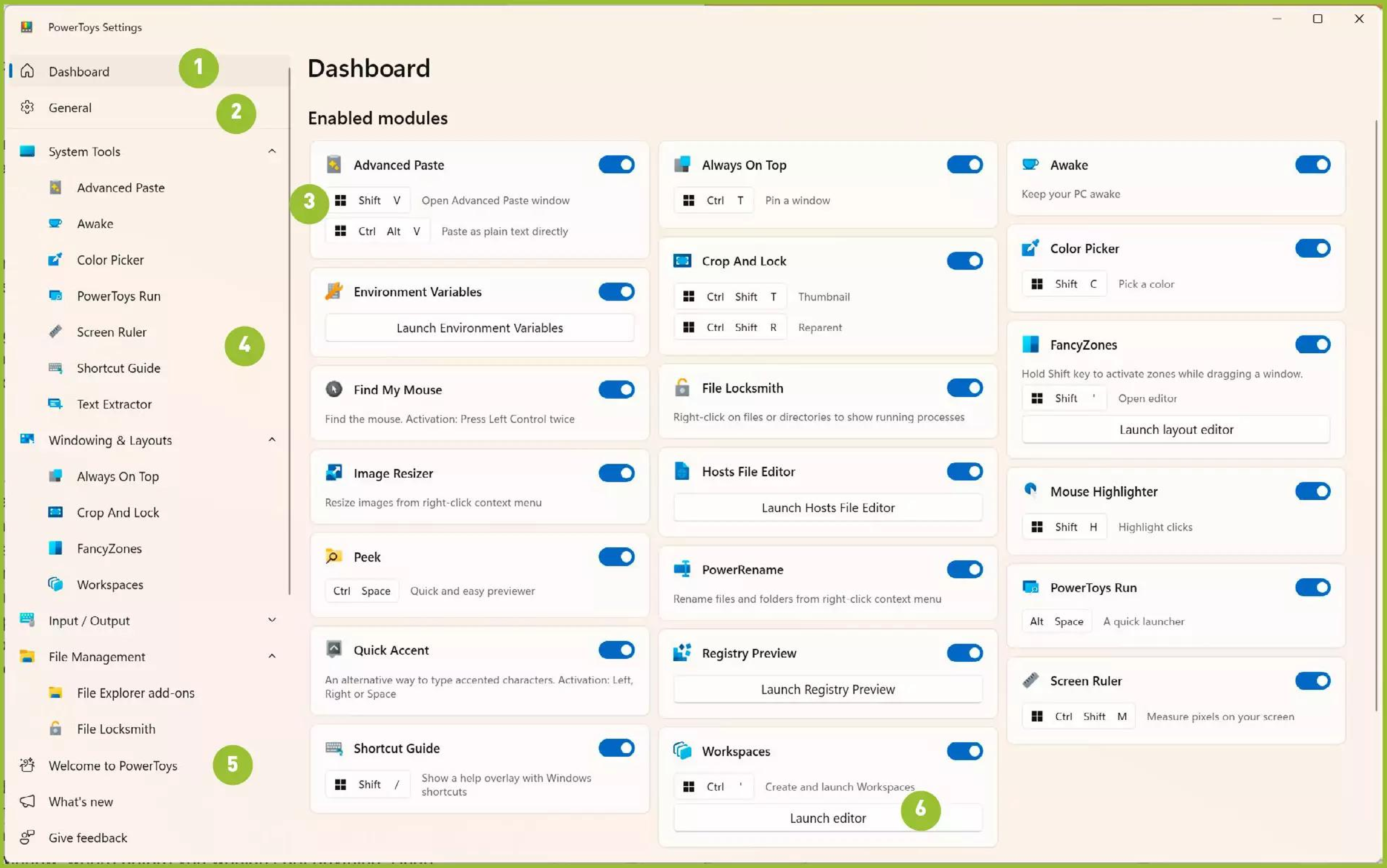
DASHBOARD DESCRIBED



Dashboard

Enabled modules

Advanced Paste
Shift V Open Advanced Paste window
Ctrl Alt V Paste as plain text directly

Environment Variables
Launch Environment Variables

Find My Mouse
Find the mouse. Activation: Press Left Control twice

Image Resizer
Resize images from right-click context menu

Peek
Ctrl Space Quick and easy previewer

Quick Accent
An alternative way to type accented characters. Activation: Left, Right or Space

Shortcut Guide
Shift / Show a help overlay with Windows shortcuts

Always On Top
Ctrl T Pin a window

Crop And Lock
Ctrl Shift T Thumbnail
Ctrl Shift R Reparent

File Locksmith
Right-click on files or directories to show running processes

Hosts File Editor
Launch Hosts File Editor

PowerRename
Rename files and folders from right-click context menu

Registry Preview
Launch Registry Preview

Workspaces
Ctrl ' Create and launch Workspaces
Launch editor

Awake
Keep your PC awake

Color Picker
Shift C Pick a color

FancyZones
Hold Shift key to activate zones while dragging a window.
Shift ' Open editor
Launch layout editor

Mouse Highlighter
Shift H Highlight clicks

PowerToys Run
Alt Space A quick launcher

Screen Ruler
Ctrl Shift M Measure pixels on your screen

1. DASHBOARD
This grid-like screen allows you to see all your enabled modules, and toggle them on and off.

2. GENERAL SETTINGS
Click here to update the software, run PowerToys in Admin mode, and change the way it looks.

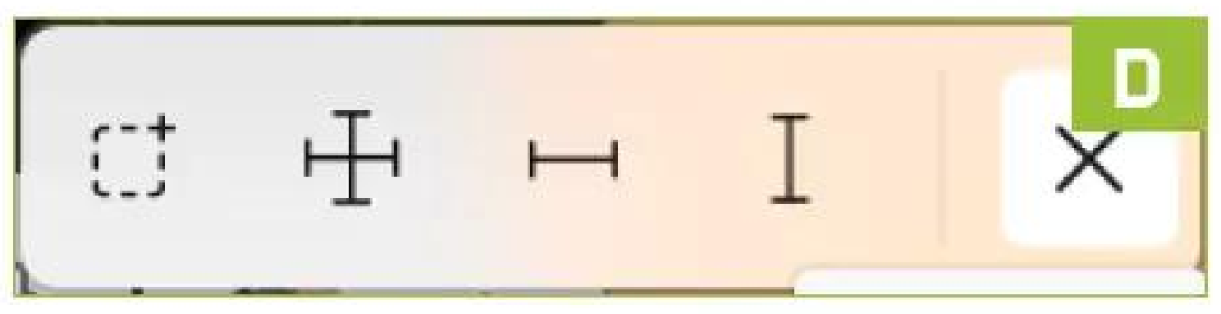
3. MODULES
These are the PowerToys themselves. Where they have keyboard shortcuts, you can see them on this page.

4. LIST
There are a lot of modules following various updates. Picking from them here can be quicker than the grid.

5. WELCOME
The Welcome page is a more friendly looking startup page for PowerToys, with a simple list of tools.

6. LAUNCH EDITOR
If a tool, such as Workspaces, has an editor app attached to it, you can launch it directly from the Dashboard.

5 QUICK ACCENT



English-language keyboards don't have diacritic marks as standard, so we have to use keyboard shortcuts or glyph palettes for an é or ü, or a word from a different language. To use it, hold the key you want to add an accent to, and press Space. A window appears at the top of the screen that's full of variations, including currency symbols, that you can choose with the arrow keys. Frustratingly, this appears to be impossible to screengrab, so you'll have to take our word for it.

6 SCREEN RULER

This PowerToy lets you measure the pixels on your screen, and has image edge detection built in. It has another shortcut, Win-Ctrl-Shift-M, to activate, which makes a small toolbar appear at the top of the screen [Image D]. This gives you four options. The first is a box that you drag out across the screen, and gives you the pixel dimensions in both horizontal and vertical axes. The other three give you the distance in pixels between objects on the screen. One shows results in both axes, one is for horizontal only, and the other for vertical. A red line appears to show you which edges it's measuring from. To stop using the measurement tools, press Esc.

7 WORKSPACES

The Workspaces Editor lets you launch and position groups of applications on your desktop. It works across multiple monitors—once you've created a Workspace, you can launch it from a list or with a desktop shortcut. To begin, open the editor from Workspaces settings within PowerToys, and click Create Workspace. Position your apps, and click Capture in the red-outlined window. You can edit the Workspace, create a shortcut to it, and pin shortcuts to the Taskbar.

8 VIDEO CONFERENCE MUTE

This lets you mute your mic and turn off your camera while you're in a conference call, no matter what app you're using. This means you only need to remember one quick shortcut, rather than a different one for every app. By default, Win-Shift-Q will toggle your audio and video feeds on and off, with further shortcuts for controlling them individually.

LAB NOTES

ZAK STOREY, CONTRIBUTING EDITOR

Maximum PC has lost one of its own

The impact Gordon had on the industry is just beyond words

WRITING COLUMNS LIKE THIS is never easy. *Maximum PC* has lost one of its greatest editors. Gordon Mah Ung passed away at the end of last year after an arduous battle with pancreatic cancer, leaving behind his wife and two children.

It's difficult to put into words just how well respected he was in the industry. In many ways, he was the father of modern *Maximum PC*. For 16 years, Gordon's voice, the way he wrote, and how he held the industry to account were pivotal to what *Maximum PC* would become: Minimum BS. Those two words line every cover we've ever produced, and Gordon was that voice; he's the reason those two words are there.

Many of you may know him from the 'No BS' podcast and his work in the Watchdog column. His contributions holding the industry to account and bringing the fight to unscrupulous companies on behalf of the consumer were legendary. His wit, humor, and technical expertise were all second to none, and from those I've spoken to, he was a brilliant human to be around, and an outstanding journalist.

If you'd like to support Gordon's family with the medical expenses, please find the GoFundMe here: **www.gofundme.com/f/join-us-in-supporting-dara-glenn-and-marianne**

Without him and his talent, I wouldn't be here today, having the opportunity to write as a career. I spent many hours as a teenager reading his content, learning everything I could, lusting after those Dream Machines. So many of my colleagues in this industry are here because of him in one way or another. His work inspired so many of us, and pushed us to become better.

I was fortunate enough to meet Gordon at Computex in 2019, stood in line with him as we waited to get into the convention hall. It was an incredibly surreal moment, seeing this legend in person, and he had nothing but good things to say about his time here. Courteous, polite, and kind, he humored me and my fanboying. I wish I'd swallowed my pride and spoken to him more.

He left *Maximum PC* in 2015, joining *PCWorld* as Executive Editor of Hardware, where he continued to deliver cutting-edge journalism for the remainder of his career. Gordon was, and is still, a legendary voice in this industry. There are no words that really do him justice. Rest well.

JEREMY LAIRD

Contributing Editor

The passing of Gordon Mah Ung is immensely sad, but it's impossible not to notice the immense positivity with which everyone remembers him. I worked with Gordon in the period leading up to his departure from *Maximum PC*. It was not, it's fair to say, the easiest ride for any of us.

The magazine was going through some structural changes, and things were happening that were uncomfortable for the existing staff, even if much of it was commercially unavoidable.

Many of the team made their reservations clear, and rightly so. But the grace with which Gordon handled the whole thing was nothing short of a life lesson. Long story short, there's a reason why Gordon is universally loved. He was genuinely exceptional.

The quality of his copy was every bit the equal of his character. Tech journalism doesn't necessarily map with top-notch prose. Maybe it's because those most interested in it are more numbers oriented. But Gordon could write, and then some. His copy was punchy, charismatic, clear, and economical. Oh, and unpretentious, just like the man himself.

As with his personal conduct, his writing set a standard we could all aspire to. In short, Gordon was one from who just about everyone who came into contact with him learned something positive. Godspeed, Gordon. Godspeed.

More and more small companies are taking the fight to the big guys.

Editor's Pick: Tryx Panorama ARGB 360

How do you like your screens in the morning?

I'LL SAY IT straight up. L-shaped AMOLED screen liquid cooler. This thing is absolutely awesome. I accidentally stumbled across this as well, like it's such a niche product, and seemingly infinitesimally rare in the industry.

I was perusing PC Part Picker one day, and happened to come across a build with a fantastically curved LCD AIO in it. I had no idea what the thing was; it wasn't even listed on the product page. I had to dig into the comments to find out exactly what this marvel was, and here we have it.

In short, this is the Tryx Panorama LCD cooler. On the surface, outside of the screen, there's not a whole lot that's obviously different compared to the competition. It's only when you look at the finer details that this thing starts to impress.

It comes with an aRGB fan and an Asetek pump design, and is available in 240, 280, or 360mm variants, in black or white. The pump itself quite closely resembles the Asus design found in its ASUS ROG Ryujin III 360 ARGB we looked at back in our holiday issue in 2024. It's got an in-built 60mm fan with adjustable speed that, despite what you might expect, is actually acting to cool the pump motor and housing rather than the screen above.

On top of that, Tryx is using a slightly thicker 30mm (1.18 inches) radiator; most AIO rads are 27mm (1.06 inches), which improves overall surface volume and fin capacity by around 11 percent or thereabouts. Tryx also reckons it's utilizing high-density fins in the radiator as well, although they don't state exactly what that density is, so it's hard to calculate just how much that might affect overall performance, compared to the competition. Given the included fans are limited to 1.8mmH2O at maximum speed, that doesn't exactly imply it's any more dense than other competing radiators.

Still, let's face it, we're all here for the screen itself. It's a 6.5-inch curved solution with a 2K resolution and a 60Hz refresh rate, delivering some wildly clear picture quality for a screen of this size. It works with Tryx's own software, Kanali, that allows you to not only take advantage of a library of 3D content, but also upload your own, split the screen into two separate segments, and set up what stats you want showing on there for monitoring. It's seriously slick, and if you've ever seen any of those 3D billboards and advertising tricks that companies use on similar corner-style displays, you'll know how epic these things can look.

The kicker? The cost. This isn't cheap, coming in at a not-so-comfortable $350 for the aRGB 360mm variant. If you want to ditch the RGB fans, go with your own. Alternatively, if you're not bothered by non-illuminated fans, there's a stock Panorama for $340 that's available. Then there's the warranty. Officially, the Tryx Panorama comes with a two-year warranty, which is fine, but to be frank, at the time of writing, that's the same length of time that the company's existed.

This is a new team of professional designers working to create products that are naturally impressive. In fact, its Luca series chassis looks just as wild and wonderful, with a floating X-shaped design, anodized aluminum, and gorgeous fine details. Still, it's very early days, so how its customer support will behave if problems arise is still very much in the air. It just doesn't have a reputation yet. **–ZS**

$350, www.tryxzone.com

© TRYX, BETHESDA

Reviewed...

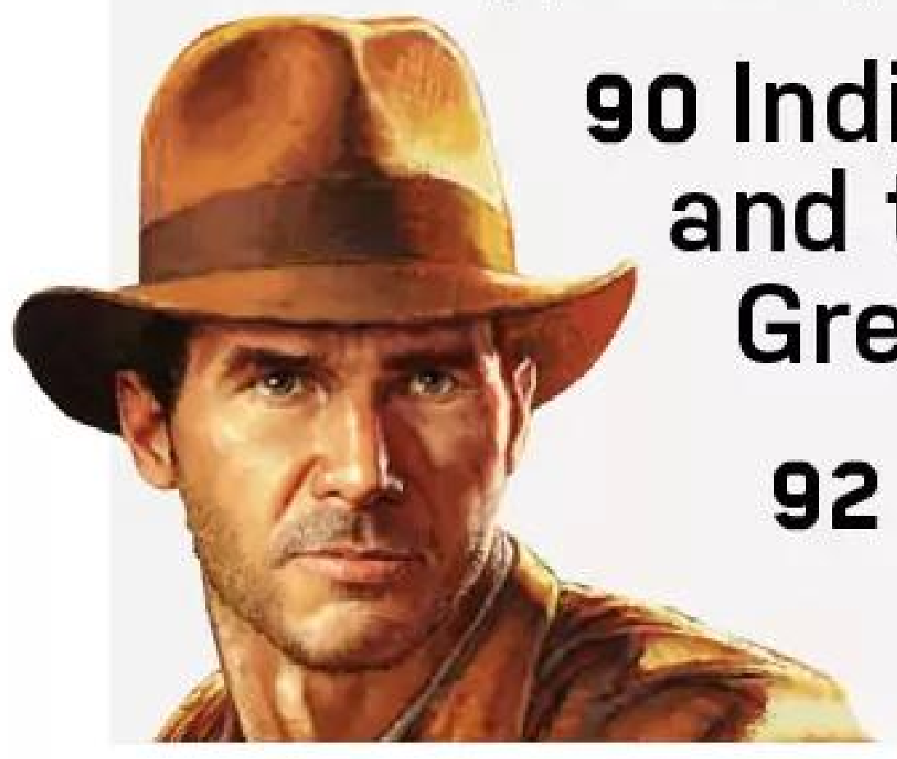
74 Intel Arc B580

76 Velocity Micro Raptor ES40
78 MSI Raider 18
80 ASUS ProArt Display 5K PA27JCV

82 Acer Nitro V 15

84 BenQ RD320UA
87 Meta Quest 3S
88 Corsair K70 Core

89 HyperX Quadcast 2
90 Indiana Jones and the Great Circle
92 Bluesky vs X



Intel Arc B580

Intel's second crack at the gaming GPU market

IT'S BEEN A LONG TIME COMING, but Intel's second-generation Arc GPUs have finally arrived. Codenamed Battlemage, the new Intel Arc B580 looks decidedly less powerful than the existing A750 GPU, never mind the full-fat A770 16GB card.

This new B580 board only has 20 Xe-cores, compared to 28 on the A750 and 32 on the A770. Even the lowly last-gen A580 has 24 Xe-cores. Well, it turns out that Battlemage brings a major architectural overhaul.

Details include much-improved mesh and vertex acceleration, along with faster ray tracing. The latter is claimed to be between 1.5 times and 2.1 times faster per XE core. Another big change with Battlemage is the move to native SIMD16 (Single Instruction Multiple Data, 16-wide) instructions, compared to Alchemist's SIMD32 units. Overall, Intel says Battlemage delivers 70 percent more performance per Xe-core.

If you do the math, a 20 Xe-core B580 should behave roughly on the level of a 34 Xe-core Alchemist chip. Of course, the B580 also clocks around 20 percent higher than before. Then there's the memory interface and capacity. Battlemage mixes things up with a 192-bit interface and 12GB of capacity, alongside 456 GB/s of bandwidth, thanks to using higher-clocked GDDR6 memory.

Those are great specs for what is, in pricing terms at least, a budget GPU. The competition is generally 128-bit with 8GB. Oh, and Intel has also delivered a second generation suite of upscaling technology, known as XESS 2, to complement the new GPU.

But what about gaming performance? For traditional rasterization, the B580 clearly comes out ahead of the competition. Against the Nvidia RTX 4060, the incumbent budget-mainstream GPU right now, Arc B580 ends up leading by a comfortable 10 percent at 1440p Ultra—exactly what Intel claimed.

The gap narrows a lot at 1080p, where the 12GB of VRAM isn't such an advantage and the B580 is only three percent faster. AMD's RX 7600 and RX 7600 XT trade blows with the RTX 4060, with the 7600 XT clearly pulling ahead at higher resolutions, thanks to its 16GB of VRAM. The 7600 XT also takes the top spot at 1080p medium, ties the B580 at 1080p ultra, and then falls behind the B580 at 1440p and 4K.

Against the vanilla AMD 7600, Intel gets a clear win. They're the same price, more or less, but Intel's B580 leads by 26 percent at 1080p Ultra settings. That increases to a massive 46 percent at 1440p, and an almost laughable 79 percent lead at 4K, where the 8GB card generally has no business trying that resolution without upscaling.

As for performance in ray-traced games, Arc Battlemage offers some much-needed competition to Nvidia. AMD's RX 7600 and 7600 XT fall well behind on ray tracing performance, and the 8GB card in particular struggles badly. While Nvidia's lowest-tier desktop RTX 4060 card doesn't exactly excel, hobbled by the 8GB VRAM as well, it easily pulls ahead of AMD's offerings.

But Intel's new Arc B580 matches the RTX 4060 at 1080p Medium, and starts pulling away at higher quality settings and resolutions. At 1440p Ultra ray-traced, the B580 is 19 percent faster than an RTX 4060.

All of this means that Intel now offers great overall value in the Arc B580, sporting 12GB at a price that undercuts the competition while offering generally superior performance. Intel's drivers still have occasional quirks, but things have improved a lot since Alchemist. If we do have a reservation, it's not actually the drivers per se, but some early indications of heavy CPU overhead.

Testing has shown that the B580 doesn't perform well with older, lower-spec CPUs. That's the case to some extent with any GPU, but the B580 seems particularly prone. If that proves to be a problem Intel can't solve, it will undermine the appeal of the B580. After all, as a budget GPU, it's likely to be paired with older, lower-spec CPUs. **–JARRED WALTON**

VERDICT

7

Intel Arc B580

+ TRULY MAGICAL Great price for a 12GB card; Strong all-round performance, including ray tracing.

− PARLOUR TRICK CPU overhead problematic when paired with low-spec processors.

$250 www.intel.com

BENCHMARKS

	Intel Arc B580	Nvidia RTX 4060	AMD RX 7600
Assassin's Creed Mirage 1440P Ultra (fps)	**80**	74	63
Black Myth Wukong 1440P Ultra (fps)	**22**	**22**	21
Dragon Age: The Veilguard 1440P Ultra (fps)	**46**	36	30
Flight Simulator 2020 1440P Ultra (fps)	**50**	42	44
Hogwarts Legacy 1440P Ultra (fps)	**52**	42	43
The Last of Us, Part 1 1440P Ultra (fps)	**45**	38	33
Star Wars: Outlaws 1440P Ultra (fps)	**34**	31	26

All tested with an AMD Ryzen 7 9800X3D and 32GB of RAM

SPECIFICATIONS

Architecture	Intel Xe2
Lithography	TSMC N5
Transistors	19.6 billion
Die size	272mm2
Xe cores	20
Clock speed	2670 MHz
Memory	12GB GDDR6
Memory bus	192-bit
Memory bandwidth	456GB/s
TBP	190W

Intel's second-gen Arc GPU brings major architectural changes.

Velocity Micro Raptor ES40

A compact PC that mixes it with the big boys

I LOVE A MINI PC. There's something compelling and satisfying about a gaming PC with the power of a massive tower condensed into something with a footprint not much larger than a shoebox. Enter the Velocity Micro Raptor ES40 gaming PC, a compact rig with serious punch and a carry handle.

Yes, the custom Velocity Micro NX2 mini-ITX chassis comes with its own pop-out carry handle. That's neat, even if you're more likely to find yourself fiddling around with it (handle goes up, handle goes down) than actually marching around with this PC.

The chassis itself actually feels very Lian-Li, all black brushed aluminum and clean lines, but without the machined edges on which I always end up shredding my fingers. Its toolless design means you can pull both the solid and tempered glass side panels off with ease, and the simple layout makes it easy to get access to the insides for upgrades, etc.

There's also a surprising amount of space inside for your graphics card. We did try to get an RTX 4090 in there, but that was a little over-ambitious. You could just squeeze one in there if you removed the front 120mm fan first, but suffice to say, you'll easily stuff cards under 300mm in length into this system, including the 4070 Super fitted for review.

Anyway, the intake pulls air in from the front and blows it across the back of the GPU, over the RAM, SSD, and VRMs, and through the push/pull configuration of the 120mm liquid CPU cooler, which vents out the rear of the chassis. It's impressive, in a chassis of this size, that the cooling is actually so effective.

Compared with the iBuyPower V40 Valorant, which comes in a larger case with a 240mm CPU cooler, the Raptor ES40 manages to keep both GPU and processor running cooler. That's counter to what you might otherwise expect, given their relative sizes. Alongside that Nvidia GPU, a graphics card made for 1440p gaming, you also get one of the latest Zen 5 processors: the Ryzen 7 9700X, one of our favorite Ryzen 9000-series chips.

Really, the only concern with this setup lies in the motherboard. With the price of this build set at over $2,500, a board with a bit more about it than a basic AMD A620 chipset board is surely in order. The Gigabyte A620I AX is a decent budget mini ITX motherboard, but it's certainly not the most feature-rich, and the 5+2+1 VRM is a little lightweight.

It's also only sporting a single PCIe 4.0 M.2 slot for your storage needs. An affordable B650I board here would have given you the option to drop in a PCIe 5.0 SSD in there, and given you a second slot for another M.2 SSD. That motherboard choice means you're also getting a limited selection of USB ports on the rear.

Those niggles aside, the rest of the spec fits the brief. The 2TB Crucial SSD isn't the fastest, but is capacious enough to give you a lot of space for your OS and game installs, and the 32GB of DDR5-5200 is plenty. There's also an excellent 750 W EVGA SFX power supply in there, too. That's a PSU that will support graphics cards all the way up to the RTX 4080 Super.

As it is, you're getting not just great 1440p gaming performance, but strong raw processing. In a world with almost ludicrous core counts being proffered between the two CPU makes of Intel and AMD, it's tempting to look upon an eight-core chip as pretty low-rent stuff, but it shows here how capable the Ryzen 7 9700X is for gaming and productivity.

The kicker, however, is the price. There is absolutely a price premium to shrinking a rig. But if you value minimal proportions and want a well-specced, powerful, impressively cool and quiet gaming PC, then the Raptor ES40 should absolutely be on your list. **–DAVE JAMES**

VERDICT
8

Velocity Micro Raptor ES40

+ VELOCIRAPTOR Great performance; Remarkably cool; Space to upgrade.

− DINOSAUR A B650 motherboard would have been better; Only one M.2 SSD slot.

$2,519 www.velocitymicro.com

BENCHMARKS

	iBuyPower RDY Y40 Valorant VCTA R003	Lenovo Legion Tower 5i RTX 4060, Core i5-14400F	Velocity Micro Raptor ES40
Cinebench 2024.1.0 (points)	1,039	784	**1,154**
Blender (samples/min)	83	60	**91**
Handbrake video encoding (fps)	80	52	**82**
Cyberpunk 2077 1440p (fps)	**49**	24	**49**
Baldur's Gate 3 1440p (fps)	82	60	**89**
Metro Exodus Enhanced 1440p (fps)	90	53	**98**
Average gaming CPU temp (°C)	66	**64**	67
Average gaming GPU temp (°C)	76	**67**	68

Best scores are in bold.

SPECIFICATIONS

CPU	AMD Ryzen 7 9700X
Motherboard	Gigabyte A620I
RAM	32GB (2x 16GB) DDR5-5200
GPU	Asus RTX 4070 Super Dual
Storage	2 TB Crucial P3 Plus
PSU	EVGA 750 W SFX
Chassis	Velocity Micro NX2

VELOCITY
GEFORCE RTX
ASUS

Only a cheap motherboard holds this otherwise premium build back from greatness.

MSI's Raider offers crazy power at a reasonable price.

MSI Raider 18 HX A14V

Dethroning a king

LAST ISSUE, we took a look at MSI's gargantuan Titan 18 HX gaming laptop. It is, without a shadow of a doubt, an absolute beast, complete with gargantuan form factor, a spec list longer than this journalist's arm, and a price tag that would make even Jensen Huang blush (probably, we haven't asked him).

It's an absolute monster, and you can price the thing up to $10,000 in its full-tilt configuration, complete with 24GB of PCIe storage and 128GB of DDR5 RAM. There's a lot to like about it, too, once you get past the price tag. In its base config, complete with RTX 4090, full-fat 14900HX, and a beautiful screen, it's a joy to use, albeit more of a desktop replacement than a laptop.

But the price, and that spec list? It just didn't make sense. It was too much. The reality is, for the vast majority, unless you're spending your days working with hours upon hours of 4K video footage, justifying that much storage and cost in a laptop is, well, difficult. For most modern-day gamers and PC enthusiasts, two to four terabytes is just, well, enough. Combine that with a wildly divisive mechanical keyboard and the most underwhelming RGB 'haptic' trackpad, and the Titan just struggled to impress. Technically brilliant, but realistically flawed.

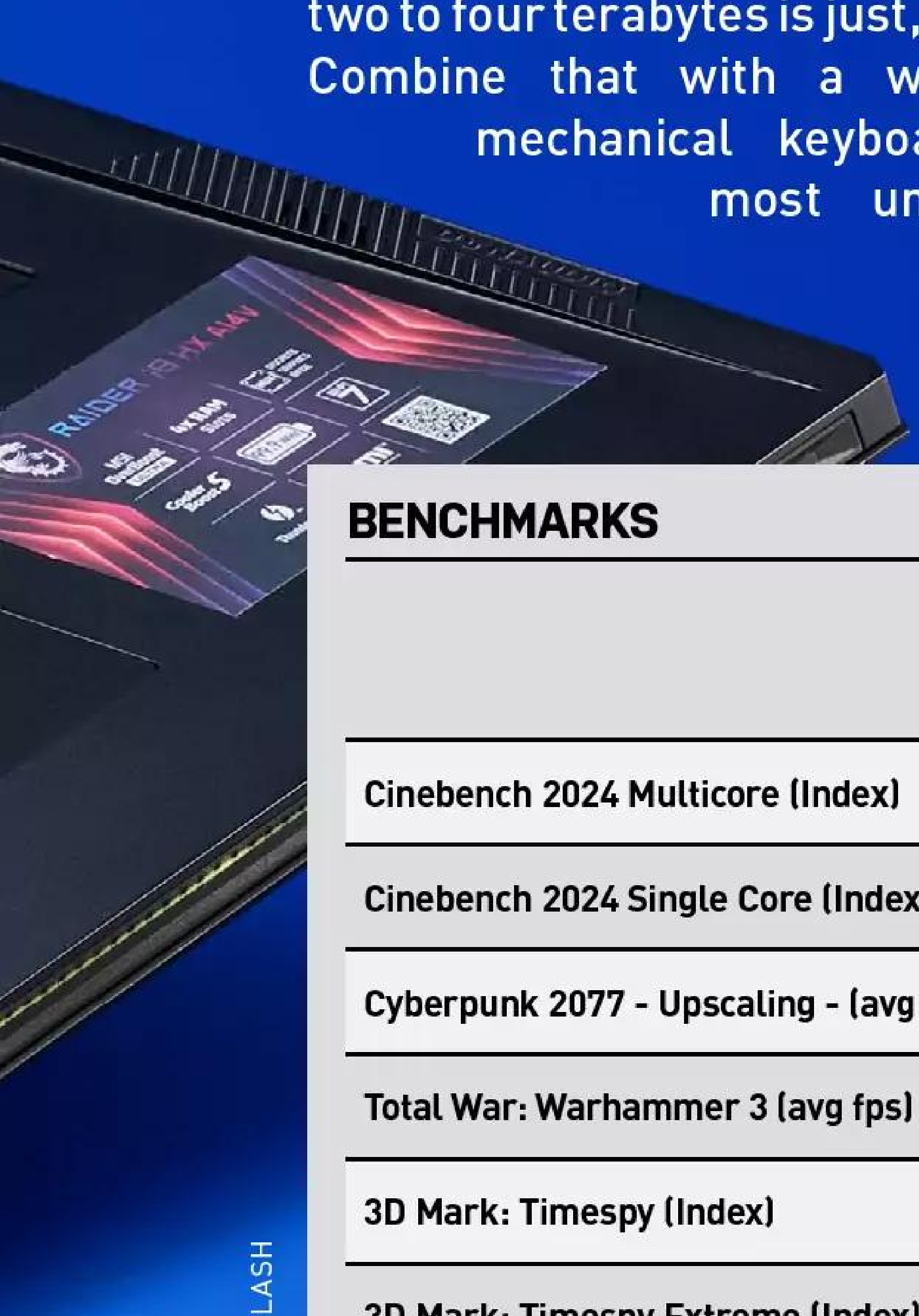
That's where the Raider 18 HX comes in. On the surface, it's incredibly similar to the Titan, but with a lot of that extra nonsense shaved off. Oh, and it's cheaper too—a lot cheaper. You still get the Core i9-14900HX, the RTX 4090, and the beautiful 18-inch MiniLED display, but the ridiculous keyboard has gone, the haptic trackpad banished to the ether, and you only get two M.2 ports rather than the four found in the Titan.

The best part, though? The price. Instead of $5,400 in its base configuration, the Raider 18 HX, with RTX 4090, sidles in for an impressive $3,870 (you can get it cheaper than this too, but you do move down to a less powerful GPU). That's over $1,500 in savings by comparison, for what effectively amounts to the same performance, certainly where it counts. Let's be clear: the screen's the same, and the internal hardware for it is the same. It's just $1,500 less, and yeah, okay, you do lose 2TB on the PCIe storage, but to be fair, you could just grab a Crucial T500 for about $130 and chuck it in yourself to make up for that.

As for performance—well, it's as you'd probably expect, given they've got the same kit and the same cooling solution. The Raider 18 delivers some seriously beastly CPU grunt, nailing 1,751 points in Cinebench 2024's multi-core test and 125 on the single core. Equally, gaming falls where we'd expect, too. 1080p Ultra easily demolished with figures well above the 100fps mark across the majority of our testing suite, and that native 4K+ panel seeing frame rates from 40-60fps in all of our test titles (with a little help from DLSS, of course).

Battery life is still no better than before, perhaps unsurprisingly, and this really isn't a laptop you should ever be taking away from its power lead, anyway. Nonetheless, it's got enough in it to last at least a few hours for the odd meeting here and there, and it's seriously quick to charge.

So then, the Raider. Honestly, it's just bizarre. It's a usurper to the crown, but it does that while coming from the same lineage as the Titan line. Why MSI decided to build this, that's so aggressively priced sat alongside the Titan, is a mystery, yet one that's more than welcome for those of us who want crazy power at a reasonable price. **–ZAK STOREY**



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VERDICT

9

MSI Raider 18 HX A14V

+ MC RAIDERS Almost the best hardware; Dominant 4K gaming; $1,500 cheaper than a Titan; Clean design philosophy; No gimmicks.

− RAID "ARRAY" Still loud; Not exactly portable; Battery life is average.

$3,870, www.msi.com

BENCHMARKS

	MSI Raider 18 HX	MSI Titan 18 HX	MSI Stealth 16 AI Studio - A1V
Cinebench 2024 Multicore (Index)	1,751	**1,777**	785
Cinebench 2024 Single Core (Index)	125	**127**	102
Cyberpunk 2077 - Upscaling - (avg fps)	**168.5**	160.6	101.1
Total War: Warhammer 3 (avg fps)	164.3	**167.2**	111.3
3D Mark: Timespy (Index)	19,861	**19,965**	12,822
3D Mark: Timespy Extreme (Index)	**10,528**	10,483	6,552
PC Mark: Modern Office Test (Minutes)	183	187	**365**
Modern	**$3,870**	$5,400	$4,099

All benchmarks performed with a clean install of Windows 11, with the latest updates, chipset and drivers installed. Best scores in bold. Games tested at 1080p on Ultra preset. Modern office test performed at 60% brightness.

SPECIFICATIONS

CPU	Intel Core i9 14900HX
GPU	Nvidia GeForce RTX 4090 16GB
RAM	64GB DDR5 @ 5600 MT/s
Storage	2TB M.2 PCIe 4.0 SSD
Screen	18-inch 3840x2400, Mini-LED, 120 Hz
Connectivity	2x USB Type-C Thunderbolt4, audio jack, 3x USB 3.2 Type A, Micro SD Card Reader, Gb Ethernet, HDMI 2.1, 330W Power
Dimensions	15.91 x 1.26 x 12.09 inches
Weight	7.94 lbs

The display controls are on the front—easily accessible for adjustments as the light changes.

ASUS ProArt Display 5K PA27JCV

An Apple Studio Display without the high cost?

AS FAR AS CREATOR monitors are concerned, companies can charge as much as they like, safe in the knowledge that those who make a living from perfect color and extreme crispness will cough up. Hence the high prices, which can rise above $2,000 for a 27-inch 5K screen.

This screen is also a 27-inch 5K, has an anti-reflection coating, and doesn't cost anywhere near as much. Five is a lot of K to squeeze into a 27-inch diagonal—4K is often considered to be a bit much for a screen of that size, with 1440p a more normal amount of resolution, but this is for those who want to edit 4K video and still have some space around the edges, or want to give their graphics card the best workout they can. The 27-inch size is about right for those who sit fairly close to their screens, as a 32-inch display can be too large, meaning you need to turn your head to view apps at the edge.

It's extremely sharp. A pixel density of 218ppi is less than that of a recent iPhone, but it's denser than most desktop monitors, including the big 4K screens. Combine this with the IPS Black panel, which corrects most of the standard IPS's tendency toward low-contrast images at high resolutions, and while you're not going to get the same contrast levels as an OLED or mini-LED screen, it's pretty good. The backlight is a standard LED, which not only keeps the illumination even, but means the screen can be fairly compact. It's heavy, though, and not something you want to hold for too long.

This is going to appeal to designers and digital artists, and its color saturation and reproduction are excellent as a result. It covers 99 percent of the P3 color gamut used by video pros, 95 percent of Adobe RGB for photographers, and 100 percent of the sRGB range, with more specialized display modes also available. It's made with content creation in mind, hence the 60Hz refresh rate that marks it out as not being a gaming monitor. Some video creators might prefer a higher refresh rate, but for anyone working on static designs, it's more than enough. It's also bright, putting out almost 580 nits, which is enough that you're going to want to turn it down rather than slamming up to its maximum setting.

Connectivity is excellent, with HDMI 2.1 alongside DisplayPort and USB-C. There's a USB hub and KVM, so you can easily swap between two connected computers. While you're not going to find a streaming stick that can output a 5K image, it does a good job of showing a 4K picture full-screen. The only weak link are its speakers, though we don't expect those built into a monitor to be of symphonic quality.

It's easy to love the ProArt PA27JCV. Its combination of a high resolution and good contrast and color handling mean that it's perfectly suited for creative work, and while it's not going to find its way onto the desks of many home workers or gamers, if you've been giving the Apple Studio Display envious glances, then this could be a less costly alternative. **–IAN EVENDEN**

VERDICT

9

ASUS ProArt Display 5K PA27JCV

+ ARTWORK High resolution, plus great brightness and color, make for an ideal creator monitor.

− BIG JERK Not a screen for everyone; Refresh rate won't please gamers.

$799, www.asus.com

SPECIFICATIONS

Screen size	27 inches
Resolution	5,120x2,880
Adaptive sync	VRR
HDR	HDR10, DisplayHDR 500
Panel	IPS Black, LED backlit
Refresh rate	60Hz
Connectivity	1x HDMI 2.1, 1x DisplayPort 1.4, 2x USB-C, 3x USB-A, headphones
Dimensions	24.1 x 21.2 x 8.46 inches
Weight	13.03lbs

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Acer Nitro V 15

A weirdly well-specced gaming notebook

YOU KNOW WHAT'S AMAZING in 2025? The fact that even now, we have so many laptops that are massively mismatched. Not from a competitive level, but rather from a pure hardware level. We've tested an absolute ton of gaming laptops over these hallowed pages in the last 12 months, and without a shadow of a doubt, the biggest problem they all have is that the graphics card in particular doesn't match the screen. It just doesn't.

Let's list the ones that this journalist has personally looked at: Acer Predator Helios Neo 14, RTX 4060 120W, 3,072x1920 @ 165 Hz screen. Acer Nitro 14, RTX 4060 100W 2560x1600 120 Hz display. Lenovo Legion Slim 5, RTX 4060 2880x1800 120 Hz OLED panel. You get the idea—at the $1,000-$2,000 price bracket, apparently everything is purely mismatched.

The notion from manufacturers is simple: 'Just game at a lower resolution, it's fine.' It's such a well-engrained premise now that if you go to any hardware reviewer worth their salt, when it comes to reviewing these pesky things, they'll almost always test at 1080p as the de facto benchmark resolution, rather than native.

We know what you're thinking, though; how did we even get here? Simply put, screens developed faster than graphics card prices dropped. Grabbing a nice, entry-level notebook with an OLED panel in it today is cheaper than you might think. Although that's great for the desktop experience and our wallets, it's less ideal when you want to actually use it for its intended purpose: gaming.

The Nitro V 15 is an absolute breath of fresh air. Why? RTX 4060 75W, 1920x1080 IPS display at 165Hz. Finally, someone did it. They paired the right GPU with the right screen, and all for $900, too.

That's the real treat for this thing. It's a remarkably well-paired device. You get 16GB of DDR5, RTX 4060, Ryzen 7 7735HS processor, a 1TB Kingston PCIe 4.0 SSD, and a (not massive, but comfortable) 59 WHr battery to boot. As a result of that, it operates as a seriously slick machine. Gaming at 1080p Ultra, in *Cyberpunk* with DLSS, delivers 73fps; *Total War: Warhammer 3* nets 71, *F1 23* a passable 40 (without DLSS), and the CPU performance is no slouch, too.

It's a simple yet well-built design, too. There's no guff here, no gimmicky gamer nonsense, or special bright red illuminated hyper-sensitive, super-response, chicken-dinner-winning trackpad—just a simple backlit keyboard, some subtle branding, and a slick bezel.

All fun and games, then? Well, sort of. Connectivity is a little old-school—WiFi 6 and Bluetooth 5.0—but you do get a dedicated Ethernet port, plus three USB Type A and one USB-C, too, meaning that you're seriously well equipped. Plus, that understatement on the looks might be a bit of a buzzkill for you. But if you're after the best bang-for-the-buck laptop that you can buy, that just works in a nice, simple 15-inch form factor, then the Nitro V 15 is a ridiculously good candidate for it. **–ZAK STOREY**

VERDICT

9

Acer Nitro V 15

+ ONE STEP FORWARD Exceptionally well specced; Solid build quality; Decent price; Good gaming performance; No fuss.

− TWO STEPS BACK Comes with a touch of bloatware; Connectivity standards dated.

$900, www.acer.com

BENCHMARKS

	Acer Nitro V 15	Acer Nitro 14	Acer Predator Helios Neo 14
Cinebench 2024 Multicore (Index)	682	799	**985**
Cinebench 2024 Single Core (Index)	91	100	**103**
Cyberpunk 2077 - Upscaling - (avg fps)	73.1	**75.4**	62.1
Total War: Warhammer 3 (avg fps)	**71.3**	70.1	56.6
3D Mark: Timespy (Index)	8,729	8,533	**9,377**
3D Mark: Timespy Extreme (Index)	4,166	3,998	**4,501**
PC Mark: Modern Office Test (Minutes)	**425**	233	389
Price (USD)	**$900**	$1,299	$1,409

All benchmarks performed with a clean install of Windows 11, with the latest updates, chipset and drivers installed. Best scores in bold. Games tested at 1080p on Ultra preset. Modern office test performed at 60% brightness.

SPECIFICATIONS

CPU	AMD Ryzen 7 7735HS
GPU	Nvidia GeForce RTX 4060 8GB
RAM	16GB DDR5X @ 4,800 MT/s
Storage	1TB M.2 PCIe 4.0 SSD
Screen	15-inch 1,920x1,080, IPS, 165Hz
Connectivity	2x USB 3.2 Type A, 1x USB 3.2 Type C, 1x 3.5mm Analog Out, 1x HDMI, 1x Gigabit Ethernet, WiFi 6, Bluetooth 5.0
Dimensions	14.26 x 9.44 x 0.93 inches
Weight	4.63 lbs

Who'd have known that pairing the right GPU with the right screen would be a win?

While it may look like a plain rectangle, the function bar gives it a bit of personality.

BenQ RD320UA

At last, a screen for reading reams of text

GAMING MONITORS are rapidly becoming the de-facto standard for a 'good' screen—they frequently come in decent sizes, with high resolutions and refresh rates, and make use of the best display technology to give your games all the brightness, contrast, and sharpness they deserve. Using a gaming monitor all day can be an excellent experience, though if you're not pumping 240Hz into one, it can feel like you're not using it to the best of its capabilities.

BenQ has shown pity on people who spend their days looking at reams of text, but want a really nice screen to do it on with its Programming Series, of which the RD320UA is a member. It's a 32-inch, 4K screen with an HDR400 rating and a lot of the usual high-end monitor features, but its maximum refresh rate is a positively pedestrian 60Hz, and its panel uses older IPS technology, rather than a lovely luminous OLED.

It does have a mini-LED backlight, though, and as we saw in the recent review of the Xiaomi G Pro 27i, this can provide excellent brightness and contrast. This screen is bigger and packs in more pixels than the Xiaomi, and costs twice as much. To justify this, it has some features that will appeal to office users and programmers, rather than gamers.

The first is the neck, which connects the stand (which screws together easily) to the back of the screen. It has a circle of lighting around the connection point, which is great if you can see the back of the monitor, but we suspect may spend its time lighting up a wall or being switched off instead. It's easy to adjust, with just over five inches of variable height, and a VESA mount if you want to put it on an arm, though watch out for the weight, as it's rather heavy, and may pull some arms down no matter how much you tighten them. A version of the monitor with a clever extending 'ergo-arm' is available, so you can twist it into more positions, but that's not the screen we were sent.

Also at the back, and particularly easily accessible due to being in a recess on the outside of the casing rather than tucked up underneath, are the inputs. We appreciate a good mix of ways to send a signal to a screen, and with HDMI, DP, and USB-C here, you'll be able to hook a good number of devices up to the screen. The USB-C connector is capable of supplying a mighty 90W of charge to a laptop, too, helping keep your desk tidy. There's a USB hub and KVM on the monitor, with two USB-A and a USB-C port switchable between the USB-C input and a USB-B that you can connect to a desktop machine.

At the front, an additional function bar descends from under the screen ready to adjust the viewing modes. There are two 'coding booster' screen modes and an ambient light sensor so that you don't strain your eyes while working on apps. The 4K resolution and good contrast means large amounts of text are sharp and easy to read, and there's a Windows app, Display Pilot 2, that can help keep on top of the screen's configuration.

While it may be a screen designed for programmers, the RD320UA's size, brightness, and contrast would make it a good general choice. The problem is that you can get 32-inch 4K screens from other manufacturers (such as those with VA panels) for much less, meaning it may be relegated to the status of 'specialist product'. **–IAN EVENDEN**

VERDICT

7

BenQ RD320UA

+ PROGRAMMING A high-contrast, highly adjustable screen for displaying text and connecting lots of computers.

– WINDJAMMING Perhaps too specialized, heavy, and expensive for general office use.

$699.99, www.benq.com

SPECIFICATIONS

Screen size	31.5 inches
Panel type	IPS, LED backlight
Resolution	3840x2160
Refresh rate	60Hz
Speakers	2x 3W
Connectivity	2x HDMI 2.0, 1x DisplayPort 1.4, 2x USB-C, 1x USB-B, 2x USB-A
Dimensions	23.7 x 28.1 x 18.8in
Weight	24.2lbs

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software.maximumpc.com

Meta Quest 3S

A Quest 2, but better. Or a Quest 3, but worse

THE FIRST TIME I put the Quest 3S on my head, I was met with a familiar sight. "This is quite a lot like the Quest 2," I thought. My opinion hasn't changed since I've got more familiar with Meta's latest VR headset. Neither should it. It turns out that the Quest 3S and Quest 2 are practically the same when it comes to optics, but the new 3S does a few things a lot better than the Quest 2.

The Quest 3S comes in two storage sizes: 128GB and 256GB, yours for $299 or $399 respectively. The larger capacity suits a decent library of games on the device itself, and thus use as a standalone headset. Anyway, the big change is the Snapdragon XR2 Gen 2 processor. This is the same processor found in the top-spec Quest 3—the 3S and S even share the same 8GB of RAM—and as a result, the Quest 3S has a lot more grunt than the older Quest 2.

In practice, this new processor certainly feels like a pretty good quality of life upgrade. Gaming through the built-in chip feels responsive and latency-free, which is key to avoiding vomit-inducing visuals, but it also feels snappy outside of games when navigating through menus or entering your details on a login page.

The Quest 3S also features full-color passthrough, thanks to the improved cameras on its exterior—two RGB cameras, four IR tracking cameras, and two IR illuminators. They enable full-color passthrough, reducing the need to lift the headset off. There's also an 'action' button on the headset beneath your right eye that lets you swiftly toggle between passthrough and full VR modes.

The main benefit to this new and improved passthrough as a PC VR user is the ability to quickly switch between VR and actually see what's happening on your computer screen. That's pretty handy if you're troubleshooting SteamVR or some PC VR game, even if these new cameras still aren't anywhere near the sort of resolution required to actually use your PC for extended periods.

Likewise, considering connecting a VR headset to a gaming PC was a fiddly job not that long ago, Air Link—Meta's built-in wireless protocol—is pretty easy to set up. Not only that, VR games are playable without a cable. I booted up a couple of games via the fairly recently updated SteamVR UI, and it's pretty slick. While these wireless connections are good, I still prefer to use my extra long Type-C cable connection for a more reliable and snappy experience, and to keep some charge going back into the device.

Comparing the Quest 3S to the Quest 2, the newer headset is a similar size. The 'arms' that hold the strap are longer on the Quest 3S, however, which means straps intended for the Quest 2 aren't compatible. Also, the speakers in these 'arms' are downward facing on the Quest 3S, which, in theory, directs the audio more toward your ears. didn't notice a massive difference in practice, but it seems like a good change nonetheless.

As for the controllers included with the Quest 3S, they're lightweight, responsive, and intuitive. That last bit matters for VR. Powered by a single AA battery, I recommend picking up some rechargeable batteries to save yourself going through heaps of single-use ones. They're the same controllers that come with the Quest 3, too, so you're not losing out on the latest gear here.

But now we must deal with the elephant in the room, and not just one inserted into my office through the power of VR. The Quest 3 is higher resolution, but more importantly, features pancake lenses to the Quest 3S's fresnels. That ensures the Quest 3 is clear and sharp across the whole image, where the Quest 3 is blurry at the edges. The Quest 3 also offers built-in glasses adjustment, IPD scroller, and auto-wake functionality that the 3S lacks. For just $100 more, compared with the 3S, that makes it a no-brainer. **–JACOB RIDLEY**

VERDICT

7

Meta Quest 3S

➕ **NOBLE QUEST** Accessible price; Easy to connect to PC; Faster processor; Full-color passthrough.

➖ **POINTLESS TREK** Quest 2 optics; 256GB model is priced too close to Quest 3.

$399 (256GB model) www.meta.com

SPECIFICATIONS

Display	LCD
Resolution	1832 x 1920 (per-eye)
Refresh rate	72Hz, 90Hz, 120Hz
Field of view	96 degrees horizontal, 90 degrees vertical
Lens type	Fresnel
IPD adjustment	58, 63, 68mm
Processor	Snapdragon XR2 Gen 2
RAM	8GB
PC connectivity	Wireless or wired over Type-C
Controllers	2x included
Weight (without strap)	464 grams

Corsair K70 Core

Corsair goes back to basics with new lubed keyboard switches

YOU CAN SPEND as long as you like comparing the specs of mechanical gaming keyboards—and if you're like us, you probably do—but there's really nothing like actually getting your fingers on the QWERTY to see which parts of your brain light up in response to the switches under the key caps.

Some like them quiet, and some like them clicky, with preferences as to how far a key moves before it activates, birthing a whole industry of customizable keyboards. There's none of that here, beyond software tweaking, and there's also none of the Hall Effect magnetic switching that we saw in the Corsair K70 Max. What you do get, for the first time ever, are Corsair's pre-lubed MLX Red linear mechanical switches—and they're fantastic.

Keyboards live or die by the feel of their keys, and Corsair has knocked this one out of the park. They're extremely smooth, with enough resistance and a high enough actuation point (1.9mm, almost halfway down the 4mm of total travel) that accidental presses aren't going to be too much of a problem while allowing you to quickly respond with a keypress to in-game events.

There's plenty of soundproofing foam inside the frame of the K70 Core. Thanks to this, the pre-lubed switches make keystrokes nearly silent if you want them to be, without case ping, although the keys do produce a sound when they return to their resting position. The keyboard strikes a balance between a satisfying mechanical noise if you ramp up your speed and power, and a reasonably quiet typing action if you don't, and as it doesn't take too much force (45g) to press the keys down (4mm total travel), the only thing holding it back from being something you can type on all day is the height of the keys themselves. If you use it for a few weeks, or if you're already used to a similar mechanical keyboard, then this may not even be a problem. There's a wrist rest in the box that attaches with magnets to the frame of the keyboard, but it's one of the few things about the keyboard that it's possible to criticize, thanks to its weird surface texture.

NICE AND SIMPLE

If you can get past that, the K70 Core does have a few other things to recommend it beyond the excellence of its switches. Its focus on simplicity, as suggested by the 'Core' in its name, means that it's a keyboard and nothing else. There's no USB hub—it connects with a single cable; no macro keys, just a few media controls and a single dial in addition to the usual number of keys. The dial is a bit of an oddity, its yellow paint making it look like it's been transplanted in from another keyboard entirely, but once the per-key RGB lighting is spun up, it doesn't appear too out of place. The lighting can be controlled from Corsair's usual iCUE software, which can be a bit dense and impenetrable to first-time users, but which comes into its own once you own multiple pieces of compatible gear. If a custom RGB display really matters to you (and there's enough memory on board the K70 Core to store five profiles so you can switch between them easily without needing to invoke the app) then it's a necessary evil.

While there are other mechanical boards out there that boast more features and better aesthetics, the K70 Core is a really good keyboard for its very reasonable price. It gets the most important thing—the feel of the keys—absolutely right. Everything else is peripheral. **–IAN EVENDEN**

VERDICT

9

Corsair K70 Core

⊞ **LUBRICATE** A keyboard with excellent feel and a fast action at a decent price.

⊟ **DESECRATE** Some strange aesthetic choices, but nothing to completely damn it.

$69, www.corsair.com

SPECIFICATIONS

Size	Full with numpad
Keys	104
Connectivity	USB 3.0/3.1, Type-A
Rollover	Full anti-ghosting (NKRO)
Connectivity	USB 3 wired, 6ft cable
Keycaps	Double-shot ABS
Switches	Corsair MLX Red (linear)
Hot-swappable	No
Media controls	No
Lighting	Full RGB per-key
Report rate	1,000Hz
Software	iCUE

HyperX QuadCast 2

An excellent plug-and-record USB microphone

THE HYPERX QUADCAST 2 is aimed at content creators who want a simple plug-and-record USB microphone. Just plug it into your PC and, out of the box, it'll deliver great audio, with no tweaking of audio settings required.

Part of that ease of use comes from the HyperX app not having many audio settings. This won't be a deal-breaker for less demanding users, considering the high-quality performance this mic delivers, but if you prefer having plenty of customization options, you may want to look elsewhere.

The HyperX QuadCast 2 offers four recording options—basically the standard set you'll find on other mics: cardioid, stereo, omnidirectional, and bidirectional. You can flick between them using the HyperX Ngenuity app, or by holding down the mic's volume knob for two to three seconds. The top of the mic will glow with different patterns to tell you which mode you're using.

Beyond the polar pattern, the app also lets you turn the high-pass filter on or off and adjust the gain (mic volume), and that's it. Given that the HyperX QuadCast 2 does a pretty good job out of the box, this lack of in-app audio manipulation isn't a big loss.

Design-wise, there's plenty to like. It comes with an in-built shock mount to reduce vibrational noise, and the in-box mic stand puts it at a good height for recording, but it easily connects to a mic arm if you have one (HyperX's own arm or a third-party alternative). The USB-C cable comes with an adapter, so you can plug the mic into your PC's USB-C port or a Type-A port.

There's also a little bit of foam-like material inside the black honeycomb pattern of the mic's frame, but it doesn't provide much in the way of an in-built pop filter to your harsh 'b' and 'p' sounds. You can outfit the microphone with an add-on like the official HyperX shield (or a third-party alternative) but there's also a free and low-tech workaround. For a solo recording, simply angle the microphone at a 45-30 degree angle, and position it so that you're talking slightly over the top of it. In the cardioid setting it'll still pick you up fine, but it won't capture those annoying pops.

Our favorite feature is the light. Using the app, you can set the mic to different presets to make it pulse, or have the mic light up as you talk, but our go-to is the 'Solid' option at about 25 percent brightness. It's a super-obvious indicator of whether or not the mic is hot, and greatly minimizes the risk of embarrassing mishaps in a work meeting or your livestream chat because you thought you the microphone wasn't recording when it was. To mute it, tap the top of the mic, and tap it again to unmute.

As a plug-and-play microphone for recording vocals, you won't be disappointed by the QuadCast 2's performance. Recordings are warm, and the cardioid mode boasts crystal-clear clarity. Whether you're hopping on a Discord call, taping a voiceover, or relying on the mic for your next gaming stream, you'll sound great, and won't be disrupted by background noise.

What makes this performance especially awesome is the fact that the HyperX QuadCast 2 sounds this good out of the box. There are no fiddly audio settings that you have to spend time customizing, or add-ons you need to buy in order to get to a good baseline.

On settings other than cardioid, however, the mic is noticeably worse at cutting out background noise, so if you're podcasting with multiple users, you'll need to get every person their own microphone.

As for cost, at $149, the QuadCast 2 isn't the most expensive option out there, but it isn't the cheapest either. You certainly get what you pay for, but while complete newcomers to content creation might appreciate this mic's ease of use, they may not be quite so happy with the price. –**HAMISH HECTOR**

VERDICT
9

HyperX QuadCast 2

+ **SOUND CHOICE'** Quick and easy setup; In-built shock mount; Great audio.

– **HARD OF HEARING** Few audio customization settings; Not cheap.

$149 www.hyperx.com

SPECIFICATIONS

Polar pattern	Cardioid, stereo, omnidirectional, or bidirectional
Sample rate	96kHz
Bit rate	24-bit
Frequency range	20Hz – 20kHz
Impedance	32Ohm
Connectivity	USB-C, 3.5mm headphone output
Weight	(Microphone) 335g; Shock mount and stand 137g; Microphone stand 273g; Total weight 819g

Now that's a reassuringly familiar sight, surely soon to be followed by mayhem...

© BETHESDA SOFTWORKS

ACTION-ADVENTURE GAME

Indiana Jones and the Great Circle

Dr Jones will steal your heart in MachineGames' best effort to date

I WASN'T OVER the moon about the prospect of a triple-A *Indiana Jones* game before starting *The Great Circle*. A new MachineGames joint—now that's something I'd hang my hat on. But Dr Jones? How many stories could there be left to tell about the Connecticut-based archeologist named after Illinois' weird little neighbor? Well, it turns out that he had at least one damn good videogame left in the tank.

Rather than the dual-wielding ultraviolence of *Wolfenstein*, *The Great Circle* is all about more brand-appropriate stealth, hand-to-hand brawling, exploration, and puzzle solving. There are guns, but limited ammo makes them more situational tools.

The Great Circle has simple, line-of-sight stealth, meanwhile, without much in the way of sound propagation, visibility control, silent ranged takedowns, or tools for keeping track of enemies. None of that stuff is particularly *Indiana Jones*, but only one of *The Great Circle*'s stealth levels feels tailor-made to these limitations.

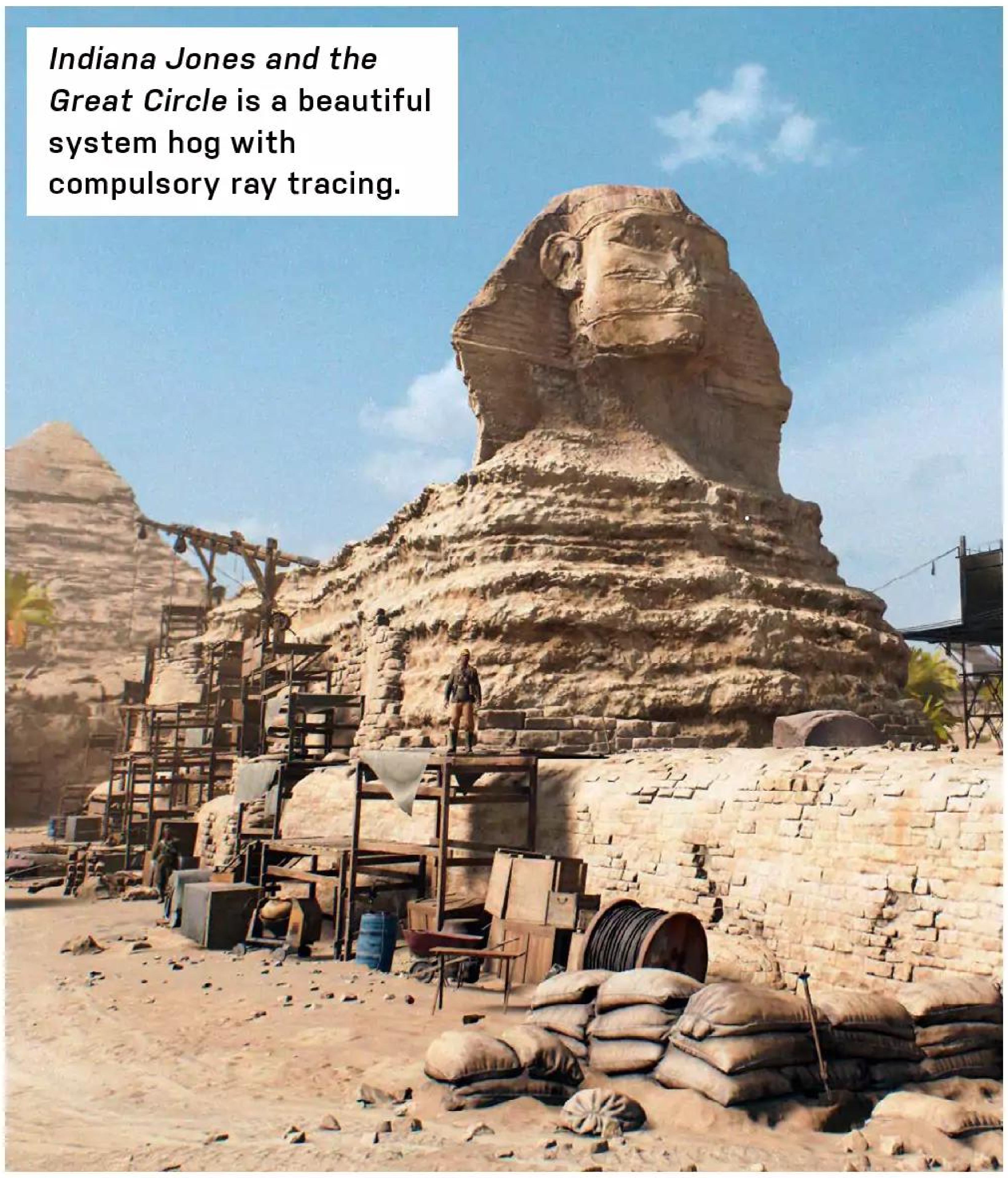
Thankfully, there are only a few mandatory examples where stealth must be used. It can otherwise be minimized through *The Great Circle*'s disguise system. Story-wise, scenes as tense and memorable as *Wolfenstein*'s train interrogation or Venus infiltration—one involving a fascist and a confession booth—gave me a real belly laugh.

You've seen the brawling here before in better and worse form. You can punch and counter enemies. On the second-hardest difficulty, I only had trouble with some optional boxing prize fights against The Fascist Heavyweight Champion of Italy and The Strongest Nazi Who Ever Lived. The improvised weapon system, meanwhile, doesn't add much mechanically, but it's an undeniable joy to see everything you can whack Nazis with, as well as their varied takedown animations.

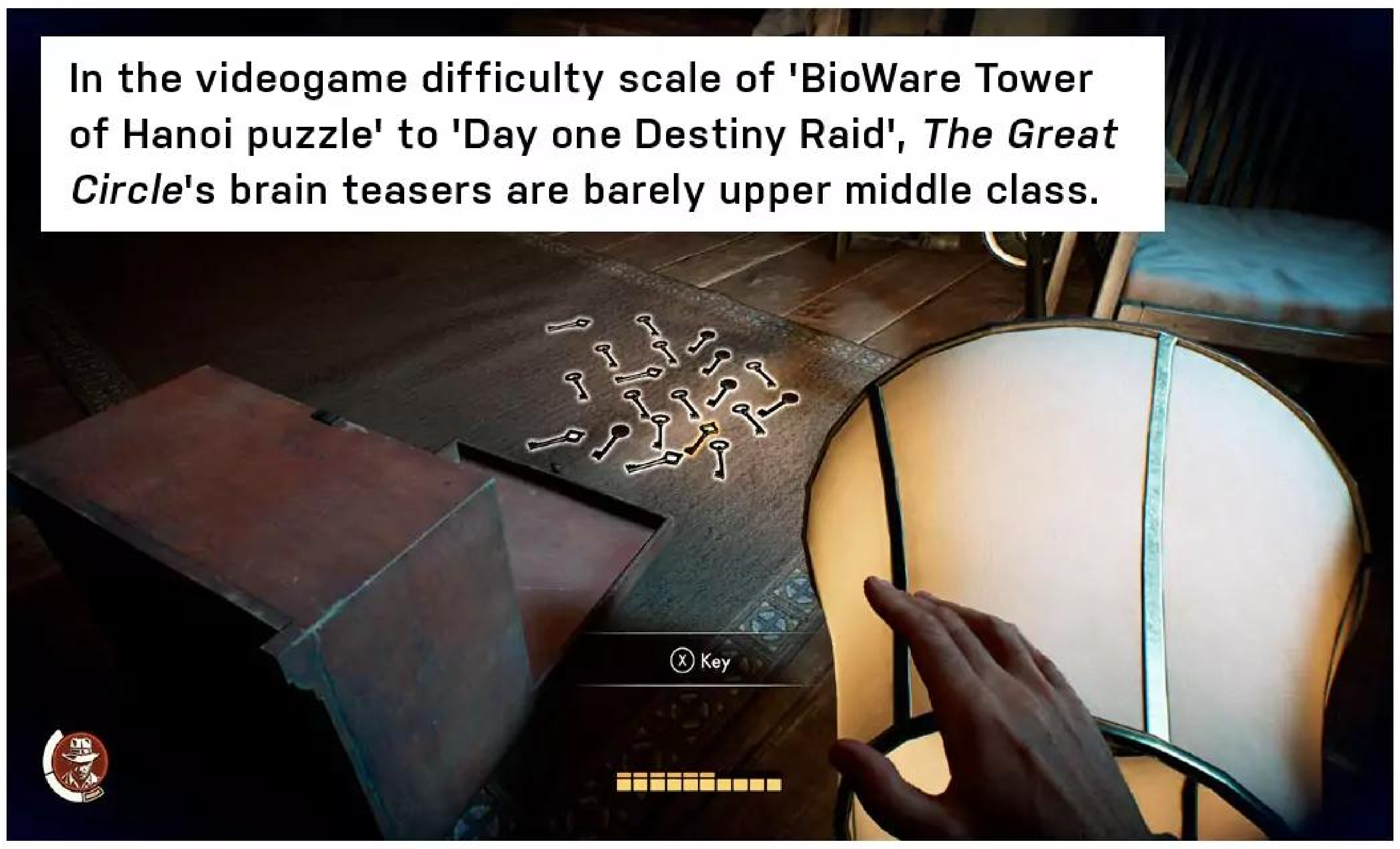
As for the puzzles, in the great videogame scale, *The Great Circle*'s brain teasers are just barely upper middle class, like a notch above *Uncharted*. I was only really stumped once, because I missed a super-obvious aspect of a puzzle's mechanics.

Overall, the game is organized around three acts with their own open-world hubs, with more linear set-piece missions stringing them together, and the design of these levels is the real triumph of the game. Indy gets a range of different objectives in the hub zones, with your main story quest front and center, a selection of three or so story and cutscene-heavy side quests that are virtually indistinguishable from the main stuff in terms of production values, and then a wide array of bite-sized 'mysteries' or one-off little side-puzzles whose stories are mostly told through notes and other clues in the environment.

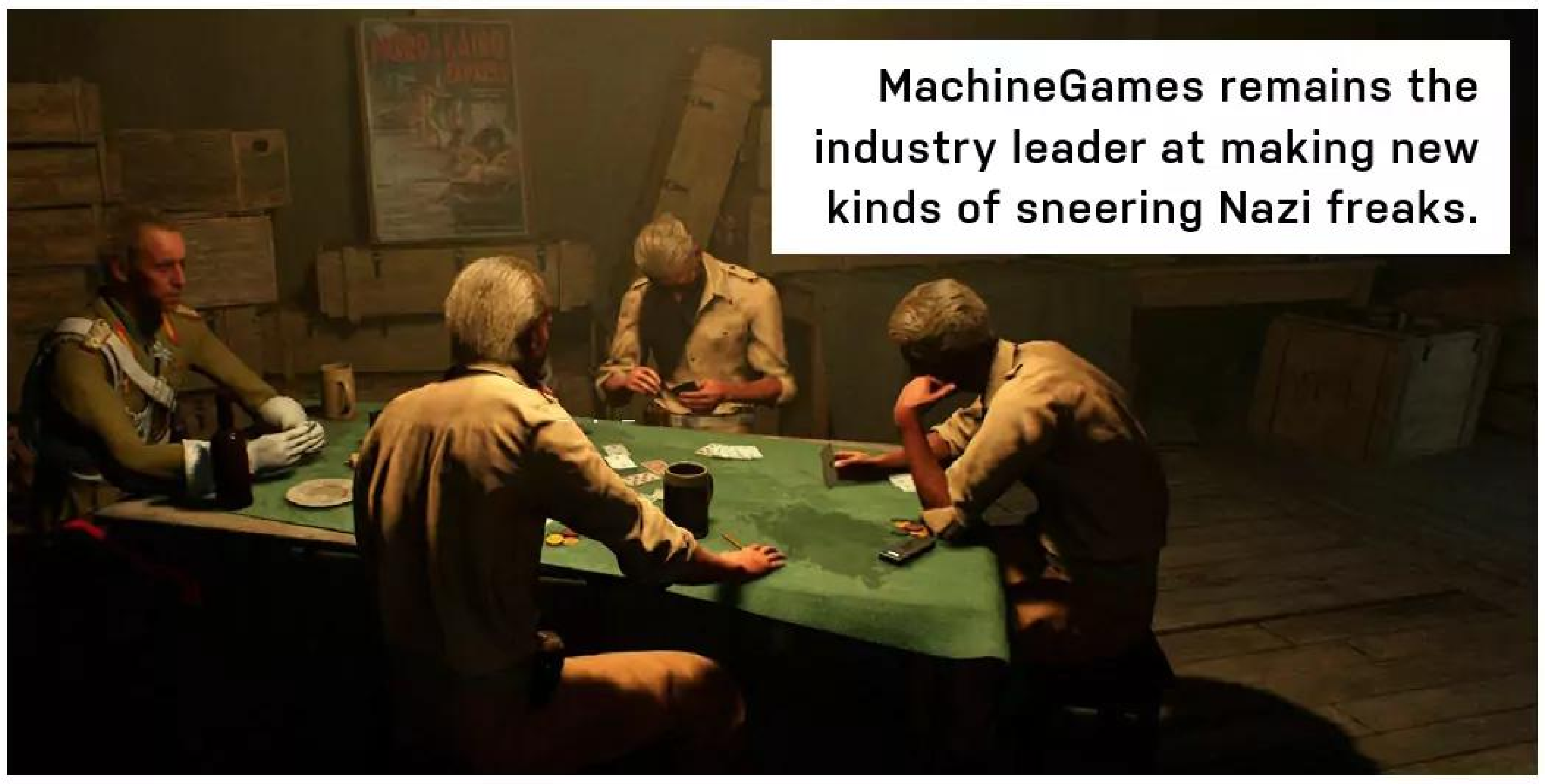
For the climactic bits of the game, *The Great Circle* does console-style, minimally interactive 'wow factor' set pieces better than maybe any game I've played. I usually don't even go for that sort of thing, but *The Great Circle* had scenes that were just so imaginative and surprising. One sees Indy catching a ride on a departing zeppelin by hooking it with his trusty whip, followed



Indiana Jones and the Great Circle is a beautiful system hog with compulsory ray tracing.



In the videogame difficulty scale of 'BioWare Tower of Hanoi puzzle' to 'Day one Destiny Raid', *The Great Circle*'s brain teasers are barely upper middle class.



MachineGames remains the industry leader at making new kinds of sneering Nazi freaks.

by a short sequence of climbing and ledge shimmying on the outside of the dirigible as Rome sprawls below you. I don't want to spoil too much, but later on, you pull off a prop plane version of the beloved Battlefield Jet Swap, and that had me hooting and hollering in my office.

Troy Baker's turn as Indy is killer, too. He gives a phenomenal performance that nails Indy's easy, everyman-concealing-academic charisma. The rest of the cast is similarly full of winners, calling to mind the great ensemble from the *Wolfenstein* games.

Graphically, this thing is a beautiful system hog. But even with lighting and textures down to low (the only setting that wouldn't give me a big old VRAM warning) and DLSS Performance mode at 1440p, *The Great Circle* is an absolutely gorgeous game and one of the best releases of the past year. **–TED LITCHFIELD**

VERDICT
9

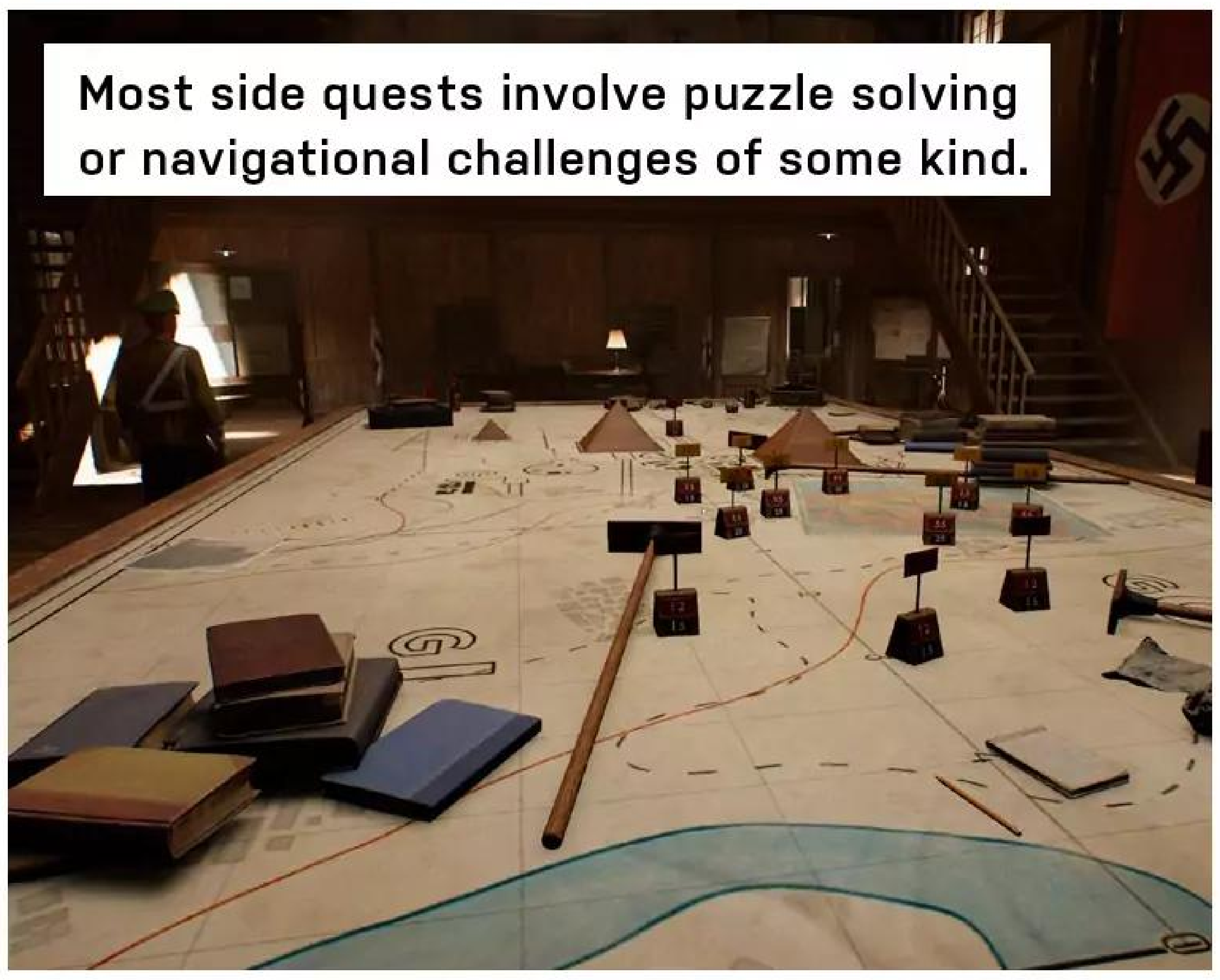
Indiana Jones and the Great Circle

RAIDERS REDUX Immersion; Atmosphere; Storytelling; Voice acting; Open-world adventures.

DIAL ME OUT Resource intensive; The stealth mechanics are a bit basic.

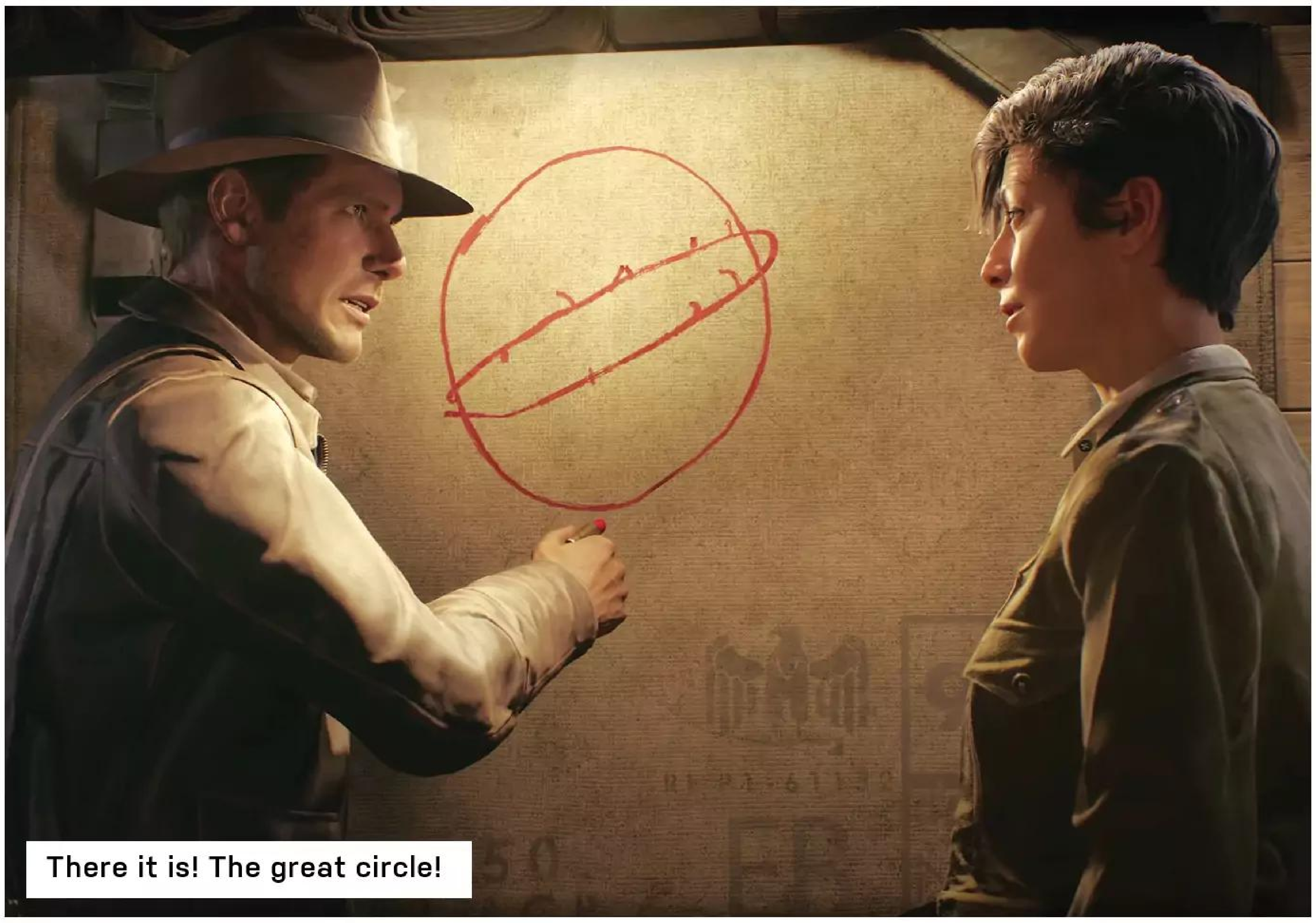
RECOMMENDED SPECS CPU, Intel Core i7-12700K or AMD Ryzen 7 7700. GPU, NVIDIA GeForce RTX 3080Ti 12 GB or AMD Radeon RX 7700XT 12 GB. RAM, 32GB. OS, Windows 10.

$69.99, indianajones.bethesda.net, Teen-rated

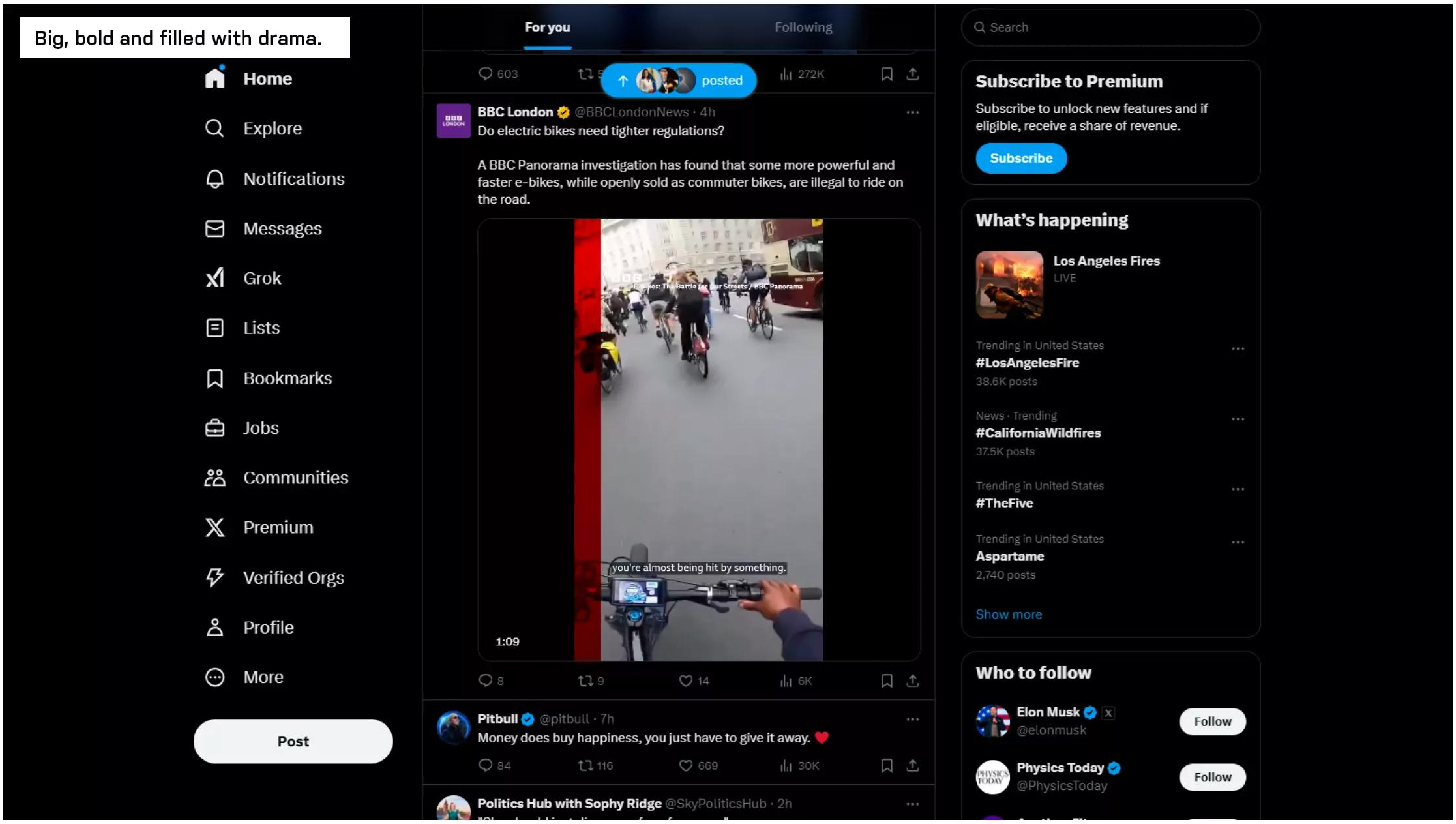


Most side quests involve puzzle solving or navigational challenges of some kind.

Don't worry, Indy's whip does indeed come in handy.



There it is! The great circle!



Big, bold and filled with drama.

BBC London @BBCLondonNews · 4h
Do electric bikes need tighter regulations?

A BBC Panorama investigation has found that some more powerful and faster e-bikes, while openly sold as commuter bikes, are illegal to ride on the road.

Pitbull @pitbull · 7h
Money does buy happiness, you just have to give it away. ❤

Politics Hub with Sophy Ridge @SkyPoliticsHub · 2h

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Subscribe to unlock new features and if eligible, receive a share of revenue.

What's happening

Los Angeles Fires
LIVE

Trending in United States
#LosAngelesFire
38.6K posts

News · Trending
#CaliforniaWildfires
37.5K posts

Trending in United States
#TheFive

Trending in United States
Aspartame
2,740 posts

Who to follow

Elon Musk @elonmusk

Physics Today @PhysicsToday

X (formerly Twitter) vs Bluesky

The battle of the micro-bloggers

IT'S A DANGEROUS business, getting up each morning and heading onto the internet. If you don't keep your feet, there's no telling what dark alley of Reddit you might be swept off to. Social media is divisive right now. From Meta announcing that it's getting rid of its factcheckers, to AI profiles springing up and pretending to be human, to algorithms perpetually drip-feeding you 10-second dopamine reels, it's a challenge to find somewhere that truly is 'social' by its very definition.

With that in mind, and the mass exodus currently erupting from X (formerly Twitter), we decided that it was about time *Maximum PC* cautiously waded into the shallows and had a look at the founding father of microblogging in today's age, and how it compares to the new kid on the block, Bluesky.

X has changed dramatically since its initial conception and its purchase by Elon Musk. From paywalls stopping direct messages and more advanced features, to algorithm shifts and advertisements running rampant, what Twitter was, to what X is now, is wildly different. It's still a social media platform, but one that has radically shifted, evolving into something very different.

To be clear, we've seen these kind of mass exoduses before. Social media users often flock to other, more modern platforms in the hopes of finding something new, something better, or something closer to what once was:. This has happened with Mastodon, Threads, and now it's Bluesky's turn.

CENTRALIZED VS DECENTRALIZED

Honestly, this very heading could have a feature dedicated to it in its entirety. The differences between Bluesky and X are deep-routed and intrinsic to the platforms, not necessarily in the content that's shared, but in how they operate at a fundamental level.

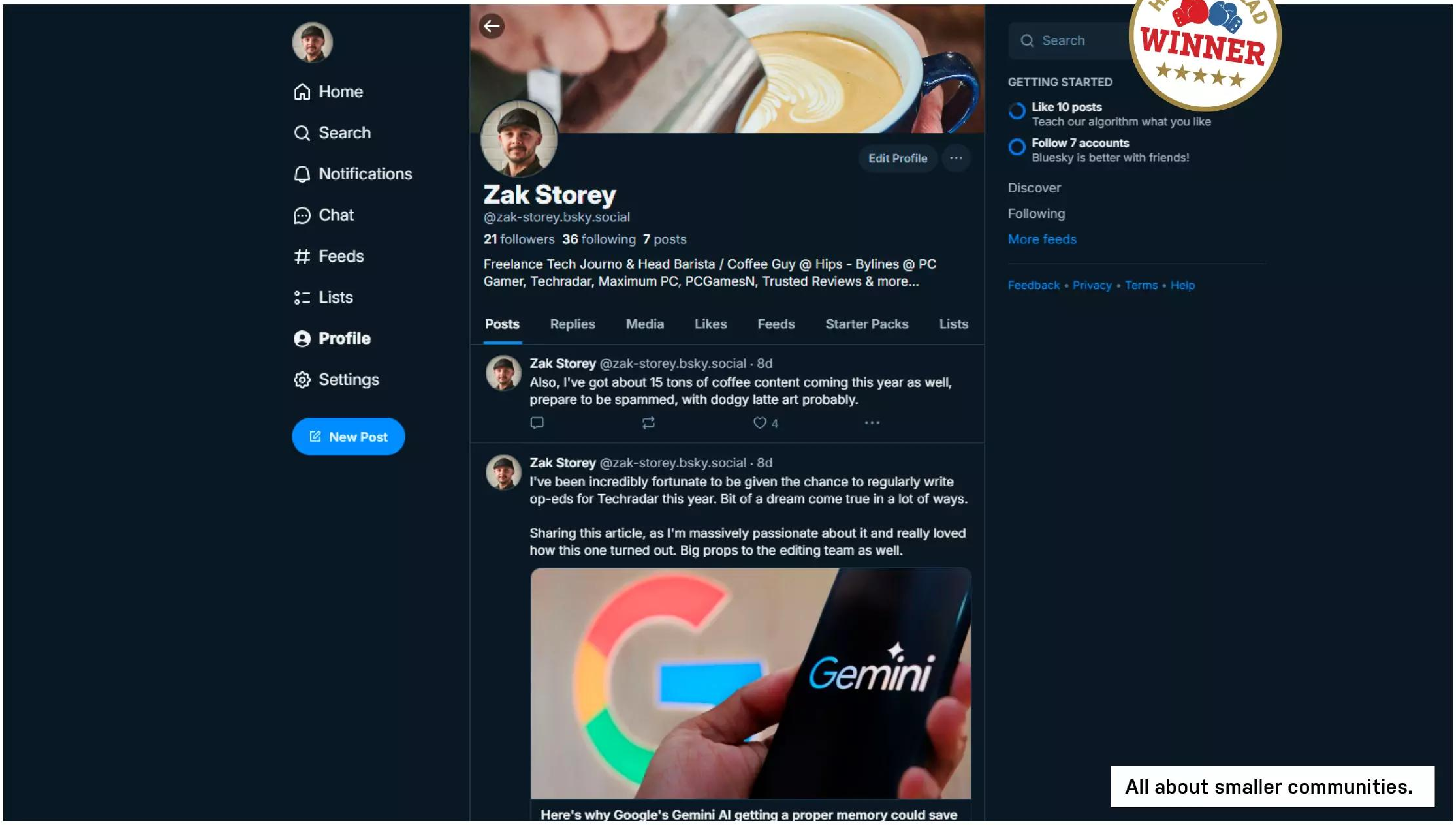
In short, Bluesky takes advantage of something called its AT Protocol (Authenticated Transfer). What this allows them to do is effectively decentralize Bluesky from a central server that the company has to manage and maintain.

While something like X manages its own servers, where all of your tweets and information is stored, allowing you to interact with everyone, in the case of Bluesky, individual servers are set up globally by communities that people then join, in not too dissimilar a manner to Discord. The communications, comments, and even moderation are then handled by that server and its community. Think of it like *World of Warcraft*: you play *WoW*, but you can only interact with people on your server, Silvermoon, unless you join another server or 'node'. Bluesky takes that one step further, as, although *WoW* has multiple servers, the data and management of those servers are still managed by Blizzard directly, while Bluesky's servers are more independent.

That does give some major benefits to Bluesky in terms of user data, as you can effectively host your own information on your own 'node' (colloquially a thread in the app) if you wanted to, although again, you'd have to convince people to join it to interact. There's a larger main node that's offered to new users, bsky.social, where you'll find the vast majority of folk, however, so it's not as aggressively decentralized as some alternatives.

© X.COM

HEAD TO HEAD WINNER ★★★★★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Profile
Settings
New Post

Zak Storey
@zak-storey.bsky.social
21 followers **36** following **7** posts
Freelance Tech Journo & Head Barista / Coffee Guy @ Hips - Bylines @ PC Gamer, Techradar, Maximum PC, PCGamesN, Trusted Reviews & more...

Edit Profile

Posts Replies Media Likes Feeds Starter Packs Lists

Zak Storey @zak-storey.bsky.social · 8d
Also, I've got about 15 tons of coffee content coming this year as well, prepare to be spammed, with dodgy latte art probably.
♡ 4

Zak Storey @zak-storey.bsky.social · 8d
I've been incredibly fortunate to be given the chance to regularly write op-eds for Techradar this year. Bit of a dream come true in a lot of ways.

Sharing this article, as I'm massively passionate about it and really loved how this one turned out. Big props to the editing team as well.

Here's why Google's Gemini AI getting a proper memory could save

Search

GETTING STARTED
Like 10 posts
Teach our algorithm what you like
Follow 7 accounts
Bluesky is better with friends!

Discover
Following
More feeds

Feedback • Privacy • Terms • Help

All about smaller communities.

In contrast, X is very much a centralized platform, controlled by a single company, and the data on those services is subject to X's own privacy and data policies as a result. That does give you a more seamless experience communicating with people, but it also means that moderation has to be handled by X directly, rather than through community groups (although again, it is worth pointing out that Bluesky does have its own moderation systems as well).

FEATURES ON FEATURES

If you're after features, gimmicks, and gizmos, X is the place to be. It's at this stage wildly advanced compared to what Twitter used to be, covering everything from lists and bookmarks to communities, jobs, and even its own AI assistant in the form of Grok, an xAI application.

It also features multiple premium subscriptions, with 'Basic', 'Premium', and 'Premium+', each adding additional features. The basic package gets you a 'small reply boost', encrypted direct messages to anyone, bookmark folders, highlights tab, an edit button (yes, really), and longer posts and videos.

Premium halves the number of ads you see, applies a larger reply boost, gives you a blue checkmark, and disables any limits on Grok, alongside returning the Tweetdeck or X Pro functionality and providing analytics; Premium+ removes ads, gives you the largest reply boost, and lets you write full-blown articles. All those tiers can be paid either annually or monthly. Monthly subs are $3, $8, and $22 per month, and the annual variants seeing discounts ranging from 11 to 13 percent.

Bluesky, on the other hand, currently has no subscription models, and its overall setup is incredibly similar to what Twitter was a decade or so ago, if not more. There's your home, search, notifications, a fairly rudimentary chat or messaging system, Feeds (where you select which nodes you want to follow or discover), lists, and that's about it.

WHICH IS BETTER?

It's a tough one to call. Politics aside, the very fact that Bluesky doesn't push you into any algorithms—just an uncurated timeline of posts from the folk you follow—is a breath of fresh air. It does, however, lack a lot of the features that made X great in its heyday. Sadly, however, as so many of those are now locked behind a subscription, that too has lost its sheen considerably.

Things like Tweetdeck were vital tools for professionals, journalists, PRs, and budding journalism graduates alike to keep abreast of the latest news and press releases—directly and carefully interacting with their communities. Yet, that's still a tool that Bluesky lacks. From a user experience perspective, if you've used one, you'll be more than comfortable using the other. Jack Dorsey's influence on both is clear to see, and that micro-blogging aesthetic seems relatively concrete at this point.

Still, for all the hubbub and drama surrounding the huge number of folks departing X for greener pastures, we wonder whether perhaps it's less about the political drama currently unfolding, and more a purer desire to return to a time where social media was simpler, more direct, and more in our control, where we weren't the product. Whether it's decentralized or not seems to matter little. **–ZAK STOREY**

VERDICT 7

X

⊞ **MARKS THE SPOT** Broad feature set; Larger community; integrated AI; Simple to use.

⊟ **EMPTY CHESTS** Riddled with ads and subscription services; Political drama.

$0 / $3 / $8 / $22 per month, www.x.com

VERDICT 8

Bluesky

⊞ **EXCELSIOR!** Simpler to use; Decentralized benefits; More community driven.

⊟ **GREYSKY** Fewer features than found on competitors.

Free, www.bsky.app

© BLUESKY

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Getting flight sim savvy
> The PC's future is bright
> Going behind the scenes

Where's the flight sim testing in Max PC?

I think it's great that *Maximum PC* uses applications like games to give us an idea of real-world performance expectations for builds and accessories. This is a blatant request for the inclusion of a flight sim game or two in the mix. The games you choose for your tests may be familiar to others who would be otherwise buying your sister PC games magazine, but most of the time, I have no idea what they are.

I looked up a few of these to see how many people are actually using them. It was interesting to see that for the most part, they pale in comparison to, say, *Microsoft Flight Simulator*, which at the time of writing seems to be over 15 million! Originally, I thought flight sims weren't being used because perhaps no one knew how to use one. But Guy disclosed his prowess in the Holiday issue Letters, so the jig is up. I do recall, in one issue way back there was a use of *MSFS*, but it was a one-off.

How about making a flight sim part of the standard test suite for evaluations? There's no doubt it's a hardware-taxing application, and I believe it would increase the general interest of many that have no clue regarding the current lineup. What'ya say?

–K. St. John

Should Microsoft's seminal flight sim appear more often in *Maximum PC*?

CONTRIBUTOR, JEREMY LAIRD, RESPONDS: The choice of game titles for our review suite is always tricky. For starters, it's impossible to be absolutely comprehensive. That's more true today than ever before, what with the divide between traditional raster games and the latest titles with ray tracing.

Then there are the ever more complex considerations around upscaling and frame generation. Should all games be tested at native resolution with no scaling or frame generation? Or should upscaling be allowed, and if so, using what platform and with how many titles?

If this seems tangential to your question, the point I'm making is that PC game testing has become incredibly demanding. Meanwhile, no matter what mix of titles and settings you decide on, it will never cover all possibilities and preferences. It's inherently a compromise now.

Moreover, even within genres, any given title will never be representative of the whole. Testing *Microsoft Flight Simulator* won't necessarily tell you how well a given GPU will perform in flight sims, generally.

On occasion, there's always the question of expediency. Access to the latest GPUs is sometimes limited, and that can leave us at risk of making the perfect the enemy of the good. In other words, sometimes it's a choice between a timely review that may lack one or two titles we'd normally like to test, and a review that's late and less relevant in that regard but more comprehensive in terms of titles tested. Ultimately, choices have to be made, and compromises struck.

All that said, *Microsoft Flight Simulator* in its various guises is a popular series, and merits consideration for default inclusion. Another option would be a periodical assessment of performance, specifically in *Microsoft Flight Simulator*, with the GPUs of the day. This is something we'll look into. If we can widen our testing to include *Microsoft Flight Simulator*, we'll do so.

↘ submit your questions to: editor@maximumpc.com

The future is bright, Gary

What's next in the evolution of CPU chips and motherboards? I've spent my entire career as a computer designer, starting back in the early '70s struggling with machine code and primitive assembler (8085 CPU and others), so I got in the ground floor with a lot of other grumbling and cursing young engineers.

Here I am, almost 80 years old, and still grumbling about the lack of progress in CPU developments and the lack of foresight in computer science and its development.

I don't care about the latest offerings in the motherboard-of-the-month crap, or its accompanying CPU. I want to hear about developments in computer science and hardware, so I can look forward to having better tools for physics and mathematics.

If you only want to cater to young game-players, then I guess I'll have to look elsewhere. Cater to the fools and idiots if you must.

–Gary Dent

CONTRIBUTOR, JEREMY LAIRD, RESPONDS: Gary, I'm pretty long in the tooth, so I empathize with your disappointment up to a point. For sure, current CPUs are nothing like the expectations that Intel created around 25 years ago. Back then, the talk was of 10GHz CPUs. Fast-forward, and clock speeds haven't gone all that much beyond the 4GHz that was possible 20 years ago.

On the other hand, core counts have exploded. That's not a benefit for all workloads, but for physics simulations, which are in your wheelhouse, the performance of current CPUs are much better than those of 20 years ago.

As it happens, we might be on the cusp of some pretty dramatic improvements. It seems that ARM chips are finally gaining traction in the PC. It just so happens that the CPU cores with by far the best performance per clock are Apple's latest ARM-compatible cores. Moreover, the ARM ecosystem is more open than that of the PC, so there's likely to be much more competition than in the somewhat stale Intel-AMD x86 duopoly.

Of course, the latest GPUs are capable of incredible performance in many parallelized tasks. GPUs aren't as flexible as CPUs, but when they can be used efficiently, I defy you to not be impressed by what they are capable of.

Finally, there's the newest processor type, the NPU. I don't want to overhype the promise of AI—the PC industry is doing plenty of that already. However, when it comes to the matrix math that's critical for running the latest AI models, NPUs are more powerful than CPUs, and make whole new application types possible.

It's hard to predict how that will play out. What will these as-yet unknown applications be? I don't know, but when the very first personal computers appeared, evangelists made similar claims.

These machines, they told us, would be used to enable as-yet unimagined wonders. Skeptics scoffed—it was obvious to them that PCs would be good for spreadsheets and other business applications, but the idea that we'd all have them in our homes, and be able to afford them? No chance.

Yet here we are. I can't tell you how it's all going to play out. All I'm fairly sure of is that the next 50 years of computing hardware and software will be every bit as revolutionary and unpredictable as the last 50. Actually, I think they will be even more dramatic. It's just a pity I probably won't be around to see all of it. As they said on a certain sci-fi series, all of this has happened before. All of it will happen again. Just more so.

TRIM that copy!

In the December issue, on page 62, it looks like you are using the Set command for the initial TRIM setting query. Shouldn't the initial query be "fsutil behavior query DisableDeleteNotify"?

–Norm T

AUTHOR, NATE DRAKE, RESPONDS: Yes, well done to Norm for spotting this, the initial command should be: "fsutil behavior query DisableDeleteNotify". This will inform readers as to whether TRIM is enabled. If the output is 1, ie disabled, then as the tutorial says, they can enable it with: "fsutil behavior set DisableDeleteNotify 0". Thanks for picking this up and letting us know!

Going behind the scenes on builds

I've been an avid reader of your magazine for decades. With 2025's end-of-life date for Windows 10, more than the average number of your readers are going to be undertaking new builds. Although your build articles and blueprints are great, how about walking us through the high-level process of parts selection that answers questions like, for example, how I avoid compatibility issues, how I decide between AMD and Intel CPUs, and how I pick the right graphics card for my budget and gaming requirements? How do I future-proof my builds? How do I pick parts that are likely to result in a simple and trouble-free build?

Having spent a career in IT, I understand the importance of bullet-proof backups. I think people sometimes don't understand that file-syncing services like OneDrive are not the same as a proper backup that includes file versioning, etc. As such, I have been a long-time user of IDrive. I don't recall *Maximum PC* recently (or ever?) reviewing paid cloud backup services like IDrive. It would be great to see a review of this service and a comparison with its peers.

Best wishes for the New Year! **–Blake Wells**

CONTRIBUTOR, ZAK STOREY, RESPONDS: I love this question, thanks Blake. Future-proofing and part-picking is an awesome angle. I'll look into doing a possible feature diving into all this, maybe a personal perspective along the lines of 'What I'd do today if I were buying a PC', along with an inside-baseball look at how I spec the Blueprints pages.

Much of how I make my choices depends on my experiences putting together builds, which means I have a good feel for what it's like to build into many of the cases in question. Factor in quoted specs, and I can begin to draw conclusions and visualize what's likely to work and what isn't.

An in-depth look would include your future-proofing and some chassis analysis, value considerations, component-by-component guidance (everything from cases of M.2 drives, PSUs, and coolers) and system maintenance. Backing up is a little outside my wheelhouse, but it is something we've covered on quite a few occasions in our how-tos and various features. It feels like a slightly separate and ultimately universal issue. It's important, for sure, but perhaps not something specific to a new build. ⏻

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THE BUILDS

THIS MONTH'S STREET PRICES...

IT FEELS LIKE EVERY MONTH, we're bracing ourselves for a new set of hardware launches. With CES finally landing, we're being graced with a whole heap of them all at once. New AMD and Nvidia cards, and new Intel GPUs have launched roughly at the same time, although admittedly the Intel ones a little sooner.

That said, right now, they're all a bit of a mystery in the world of *Maximum PC*; we're still awaiting review samples and units to land with us, to figure out how exactly these cards tick. Nvidia has already announced that the RTX 5070 will deliver just as much performance as an RTX 4090, but at almost one quarter of the cost. Whether that's true remains to be seen.

The long and the short of that? Unless you find an astonishingly good deal, it's worth avoiding picking up a graphics card until the official reviews launch (at which point we'll have rejigged our Blueprints segment here as well).

With that in mind, we're changing a lot in our budget builds, predominantly in the land of AMD, finally dropping the Ryzen 5 7600 and bringing in a 9600X, plus a new B850 board (we've got one in for the next issue). That has skyrocketed the cost of our build up quite a bit, not only as the mobo and CPU bumped up the cost, but also as we needed to add a standalone CPU cooler. For our red build, we still slid under $1,000, but only barely, with the total cost shooting up by $138 on last month.

Not to leave our Intel setup out in the dark, we also chucked in the same be quiet! Pure Rock Slim 2 cooler here. Yet, aside from that, we're still hanging on to the Core i5 14400F, as it's just such a good deal right now.

As for a good budget GPU, this one we can say with confidence: get an Intel Arc B580. Right now, it's just the best budget card money can buy, if you can find one in stock. Check out our build feature on page 16 to learn more.

AMD INGREDIENTS

PART			PRICE
Case	Phanteks XT View		$88
PSU	600W Thermaltake Toughpower GX2 80+ Gold	NEW	$57
Mobo	Gigabyte B850 Eagle WiFi6E ATX	NEW	$170
CPU	AMD Ryzen 5 9600X	NEW	$250
Cooler	be quiet! Pure Rock Slim 2	NEW	$25
GPU	Sparkle ORC OC A750 8GB		$200
RAM	32GB (2x 16GB) Silicon Power XPOWER Pulse Gaming @ 6,400 C32		$88
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2		$41
SSD 2	1TB Klevv CRAS C910 PCIe 4.0 M.2		$50
OS	Windows 11 Home 64-bit OEM	NEW	$22
Approximate Price:			**$991**

INTEL INGREDIENTS

PART			PRICE
Case	Phanteks XT View		$88
PSU	600W Thermaltake Toughpower GX2 80+ Gold	NEW	$57
Mobo	MSI Pro Z790-S WiFi ATX	NEW	$150
CPU	Intel Core i5-14400F		$154
Cooler	be quiet! Pure Rock Slim 2	NEW	$25
GPU	ASRock Challenger OC RX 7600 8GB		$250
RAM	32GB (2x 16GB) Silicon Power Value Gaming @ 6,000 C30		$88
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2		$41
SSD 2	1TB Klevv CRAS C910 PCIe 4.0 M.2		$50
OS	Windows 11 Home 64-bit OEM	NEW	$22
Approximate Price:			**$925**

MID-RANGE

ON THE MID-RANGE FRONT, all of our systems have remained fairly stable this time around. Team Red decreased by a total of $23 thanks to a major price drop for the Hyte Y40, plus some other savings here and there (don't worry, we're getting around to that OS swap).

Unfortunately, there has been a slight price increase in the RX 7700 XT's (lightly in light of the new AMD cards launching in the next few months), which did impact the overall pricing a bit more than we'd like, but it's a comfortable build for those looking for a mid-range system. Again, given we're due new GPUs, it's definitely worth waiting for those cards to land instead.

As for our Intel system, you'll spot that not a single thing has changed. The 14700F remains the mid-range chip of choice at $317, and the overall pricing has stayed relatively stable, with ups and downs here and there leading to a grand total of costs going up by a comfortable $25. That was mostly down to all of the RTX 4070s jumping in price by $40 on last month. Simply put, you just can't find an RTX 4070 for less than $550 right now.

Lastly, we've re-checked consistent pricing for Windows 11 OEM (one-time use) keys, and they've seen a marked drop in the last year or so. Combine that with the fact that this year, Microsoft is stopping its support for its "last ever operating system," Windows 10, no longer producing software updates, tech assistance, or security fixes—we're all going to have to be on Windows 11. Just make sure you pick up your OEM key from a reputable vendor. You're far better off grabbing a full-fat Windows license and tying it to your Microsoft account. It might cost more, but it's helpful for those rapid reinstalls we're fans of. We also asked Google Gemini what we should do; apparently, you can 'run Windows 10 without updates' (not recommended) or 'buy a new PC'. So there you go, the AI gods have spoken.

AMD INGREDIENTS

PART		PRICE
Case	Hyte Y40 ATX Mid Tower	$99
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold	$95
Mobo	Gigabyte X870 Eagle WIFI7	$201
CPU	AMD Ryzen 7 9700X	$319
Cooler	Noctua U12S chromax.black	$90
GPU	Asus Dual OC RX 7700 XT 12GB **NEW**	$410
RAM	32GB (2x 16GB) TeamGroup T-Create Expert @ 6,400 C32	$88
SSD 1	1TB Lexar NM790 M.2 PCIe 4.0 SSD	$70
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD	$93
OS	Windows 11 Home 64-bit OEM **NEW**	$22

Approximate Price: $1,487

INTEL INGREDIENTS

PART		PRICE
Case	Hyte Y40 ATX Mid Tower	$99
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold	$95
Mobo	MSI Pro Z790-VC WiFi	$160
CPU	Intel Core i7-14700F	$317
Cooler	Razer Hanbo Chroma - 360mm AIO	$80
GPU	MSI Ventus 2X OC RTX 4070 12GB	$550
RAM	32GB (2x 16GB) Silicon Power Xpower Zenith Gaming @ 6,000 C30	$84
SSD 1	1TB Lexar NM790 M.2 PCIe 4.0 SSD	$70
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD	$93
OS	Windows 11 Home 64-bit OEM **NEW**	$22

Approximate Price: $1,570

TURBO

AS WITH OUR BUDGET BUILDS, in the land of the Turbo rigs, the changes are equally as potent for Team Red. We've finally bit the bullet and once again jumped up to AMD's latest generation and the flagship Ryzen 9 9950X. Complete with 16 cores, 32 threads, 64MB of L3 cache, and a whopping 5.7GHz clock speed, this thing is an absolute monster at multi-threaded apps, and isn't exactly a slouch in the single-core/gaming department, either.

Again, though, this has led to some significant cost increases, including a $93 bump up in motherboard cost (we just had to splurge on an X870E setup), and a whopping $101 over last month's 7950X. To be fair, AMD has bumped up the price of that chip by $57 this month anyway, so that was a necessary sacrifice, to be quite frank.

Other changes include a new PSU in the form of EVGA's SuperNOVA 1000 P5, as all of Super Flower's Leadex units had jumped up above $200, and that's about it. One thing to note: the new RTX 5090 is set to draw 575W of power, with a 1000W PSU recommended. They're still using the same 600W 12HVPWR solution (RTX 4090 was limited to 450W), but given how power hungry the last generation was, it may be advisable to go for an even higher watt PSU, although we can't confirm that 100 percent just yet.

For our Intel rig, we're still sitting on that 14th gen for the time being, and again, changes are fairly minimal across the whole rig, the only exception being that GPU. We've swapped the Zotac card for this stunning MSI deal, as the Zotac card had shot up by (hang on a minute, we've got the note here somewhere), ah yes, that's it, $525. Boy, they do know how to make this job easy.

Despite all the changes, then, our AMD build has gone up in price by a svelte $241, and our Intel build has dropped by $8, but again, hold on for those new GPUs.

AMD INGREDIENTS

PART			PRICE
Case	Geometric Future Model 5		$139
PSU	EVGA SuperNOVA 1000 P5 1000W - 80+ Platinum	NEW	$183
Mobo	Gigabyte X870E Aorus Elite WiFi7 ATX	NEW	$320
CPU	AMD Ryzen 9 9950X	NEW	$594
Cooler	NZXT Kraken 360 360mm AIO		$170
GPU	ASRock Phantom Gaming OC Radeon RX 7900 XTX 24GB		$930
RAM	64GB (2x 32GB) Patriot Viper Venom @ 6,400 C32		$135
SSD 1	2TB Crucial T700 PCIe 5.0 M.2		$270
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2		$140
OS	Windows 11 Home 64-bit OEM	NEW	$22

Approximate Price: $2,903

INTEL INGREDIENTS

PART			PRICE
Case	Geometric Future Model 5		$139
PSU	EVGA SuperNOVA 1000 P5 1000W - 80+ Platinum	NEW	$183
Mobo	MSI MPG Z790 Edge WiFi ATX	NEW	$200
CPU	Intel Core i9-14900KF		$434
Cooler	Asus ROG Strix LC II ARGB 360mm AIO		$145
GPU	MSI Ventus 3X OC RTX 4080 Super 16GB	NEW	$958
RAM	64GB (2x32GB) TeamGroup T-Create Expert @ 6,000 C34		$166
SSD 1	2TB Crucial T700 PCIe 5.0 M.2		$270
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2		$140
OS	Windows 11 Home 64-bit OEM	NEW	$22

Approximate Price: $2,657

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